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| 1884 | " | 82 | " " | 1891 | " | 325 | " " |
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**Ferraris vs. Tesla.** THERE still seems to be a doubt in the minds of some people as to whether it was Tesla or Ferraris who first invented or discovered the rotary field as applied to alternating current motors. There seems to be no question that Ferraris invented it before Tesla; this fact, we believe, Tesla himself admits. But it seems to be equally certain that Tesla invented it independently without any knowledge of Ferraris' work, in proof of which it may be of interest to note here that Prof. Ferraris, with becoming modesty, in a personal conversation with the writer, stated that he believed Tesla to have had no knowledge of Ferraris' work, and was therefore an independent inventor of this principle; he furthermore added that Tesla had developed it far more than he, Ferraris, had, for which he deserved great credit, in addition to having been an independent inventor. Such a statement coming directly from Prof. Ferraris himself ought to relieve any one of a doubt, and ought to close the controversy.

**Electric Lighting in Massachusetts.** THE admirable report of the Massachusetts Board of Gas and Electric Light Commissioners contains a great amount of statistical information in regard to central station electric lighting in that State, from which some interesting extracts are printed on another page. While the amount of money invested is considerable, it is not proportionately as large as in New York State, in which there were 129 stations in 1890 with $30,000,000 invested, and where at present there are more than 160 central stations. It is interesting to note that the large stations with scarcely an exception pay good dividends, those in Boston, with less than one-fourth the aggregate investment, paying more than one-half of the aggregate dividends at the rate of 7 per cent. The poorer showing of the minor stations does not necessarily imply any discouraging future for electric lighting in the smaller towns. In many such cases the surplus is devoted to the increase of the plant or in improvements, the cheap manner in which many small plants are installed soon making changes and further investmen s necessary. In many localities the necessity of securing a franchise to keep others out of the field has resulted in the construction of stations which are operated at a present loss, but with a future that makes the investment a satisfactory one. Then again are the cases in which plants have been installed when under the influence of the electrical craze, which do not permit the victims to take a business view of the situation until too late to retreat. This interesting report is a reminder, by the way, of the U. S. Census statistics on the subject of electrical industries in general, which are still in the census office with no immediate prospect of being published, and as the data will presumably refer to the year 1890, the greater part of their value is already lost.

**Electrical Units.** THE discussion before the Société Internationale des Electriciens on the proposals of the American Institute of Electrical Engineers in regard to electrical units calls attention to the subject of the unit and standard of illumination which, no doubt, will receive the particular attention of the International Electrical Congress to meet at Chicago. The proposition to substitute the word "lux" for "bougie metre" deserves consideration, not only on account of the much greater convenience of the proposed name, but also because its form does not involve a departure from the system heretofore followed in naming units. A much more serious question is the subject of a standard of illumination. The absolute Violle or platinum standard adopted in 1884 is useless from a practical point of view, and the proposed Hafner-Alteneck amyl-acetate standard is in turn criticised. The proposal by M. Blondel of a secondary standard for the measurement of arcs will also probably come before the congress, so that the discussions in this branch will form an important part of the proceedings. There is no doubt as to the need of an arc standard, owing to the difference from the ordinary standards in the quality and intensity of the light; and if the rather startling statement of the constant emissivity of the surface of any arc crater can be definitely established, the standard proposed will be of great value. The discussion as to the value of the proposed unit of magnetic flux, the weber, foreshadowes a probable difference of opinion that will come up before the congress, when, no doubt, the advisability of the addition of all the proposed units to the present large list will be energetically discussed.

**Accumulators in Central Stations.** THE description of the municipal electric plant of Berne, Switzerland, in another column, calls attention to the prevalent European practice of using storage batteries as auxiliaries in central lighting stations. In the present instance the batteries are used, it is stated, to either assist the dynamos or supply all the current alone during the period when the demand becomes small. It is probable that the latter use is the one they are primarily designed for; but in the case of a station overloaded during a short period they would prove very useful to tide over this difficulty, and defer an increase in the plant until the overload became more important. Such an occasion would furnish a good opportunity for putting in an accumulator plant, which afterward could be entirely devoted to supplying the circuit alone during the hours when the demand is light. The advantage of being able to shut down the dynamo plant after midnight, particularly in the summer time, when it will not be required again in the morning, is so evident that it is surprising that Americans have not joined the Europeans in profiting by it. The loss of energy by the double transformation, which may be urged against this system, is largely or entirely balanced by the greater efficiency of the machinery worked at its most economical point in charging, so that the large savings in other operating expenses are only offset by the battery expense account. Perhaps one reason for the lack of advance in this direction has been that the manufacture of the large and sturdy storage plates used for this purpose has not been undertaken, and their adoption commercially urged, in this country. In the light of European experience this seems to be a field that would be a profitable one for the manufacturer to enter.

**The Telephone Situation.** INQUIRIES continue to reach us in regard to the status of the telephone patents, which evince in a very practical way the interest felt by the public in the expiration of these patents. The situation has been modified in the direction of simplicity since our last article on this subject was published, by the decision of the Supreme Court in Huber vs. Nelson Manufacturing Company, rendered by Justice Blatchford on March 27, which holds that a United States patent issued subsequently to an English patent, and after the latter has expired by reason of non-payment of taxes, is void. Such was the history of the Edison carbon transmitter patents, which covered pretty broadly the use of carbons in telephone transmitters. So far as carbon is essential to this purpose it is now open to the public—the broader claim of variable contacts, however, is embraced in the Berliner patents, which still have fifteen years to run. The validity of the Berliner patents, however, has been called in question, and has not been affirmed in courts of last resorts. In our last issue we called attention to the claim of the American Bell Telephone Company that the Blake transmitter patents had not yet expired, as generally supposed, and their statement that the question involved had not yet been passed upon by the highest courts. This claim that the United States Supreme Court had not yet passed upon the question is true as far as it goes, but the fact is that it has been decided time and again by the circuit court and others of lower standing, and these decisions have been invariably adverse to the Bell claims. Unless the United States Supreme Court should overrule the decisions of the lower courts, which it seems scarcely likely to do in the opinion of many, the Blake transmitter patent, that is, the basic patent, *has* expired. However, as we have pointed out, transmission of articulate speech by means of undulatory currents of electricity, which constitutes the art of telephony so far as it has been developed, has been open to the public since the expiration of the basic Bell patent of March 4, 1876, and the Bell receiver, which as has been shown is also an excellent transmitter even for very long distances, as now constructed, will cease to be protected after Jan. 30 of next year.

**The Electrical Bicycle Road.** IN another column is given an interesting description of the Boynton Electrical Bicycle Railroad and car which are to be tried shortly on Long Island near Patchogue. While the public is already familiar with the bicycle principle as exemplified by the short road between Gravesend and Coney Island that has been in operation for some time, additional interest is attached to the present experiment, because this will be the first case in which electricity is employed as a motive power. The motor to be employed will be one of singular compactness—the two armatures, which are fixed to either side of the driving wheel with the interiorly located field magnets, are but 18 inches in thickness, including the driving wheel—and is built for a capacity of 75 h. p. This, it is said, it will develop at 60 revolutions. With a driving wheel of five feet this would mean a speed of nearly 1¼ miles per minute, but we do not understand that any such speed will be attempted. It is announced that when the road is completed between Patchogue and Brooklyn a speed of 100 miles an hour will be attained, but that for this purpose motors will be attached to both wheels. This will undoubtedly be necessary in order to get sufficient track adhesion. In fact, the question of track adhesion would seem to be the greatest one involved in this proposed fast transit, as the speed of revolution of the armature in an electric motor is not limited by valve movements and clearance of ports, as in the steam locomotive. In the initial experiments it is understood that the driving wheels used will consist of steel tires filled in with teak wood. While this filling with wood will conduce to noiselessness of running and answer for the slower speeds, for the higher rates a stronger web will be required to resist the tendency to fly apart due to centrifugal force. This latter is an element that must be combatted in extreme high speeds, but it is believed may be safely provided for. Calculation shows that for a given speed of train the centrifugal force will be the same, whether the wheels be large or small, the greater angular velocity of the smaller wheels making up for their lesser radius. This being the case, wood must be abandoned in the guide wheels as well. The question of high speed is now an absorbing one, and the public will watch with interest each attempt to break the record.

## Easter Decorations.

O common has the use of electricity become for decorative purposes that, any display ceases to attract marked attention unless it is of unusual beauty and brilliancy. Many of the merchants and dealers in New York City have now come to employ electrical devices, either for decorative or advertising purposes, and illuminated signs are now placed in some of the most conspicuous positions, such as in Madison Square and along Broadway. It is on Broadway, perhaps, that the best facilities for this sort of work exist and where most advantage has been taken of them. As the Edison underground mains follow this street and most of the shops and stores are lighted by electricity, it is an easy matter to secure current for any sort of work in this direction, and the result is that a great many of the windows along Broadway are very handsomely decorated and illuminated. At Christmas time and during Easter holidays this is particularly noticeable.

In the accompanying illustration is shown the decoration which appeared in the window of a well known Broadway florist during Easter, and which attracted much favorable comment. Its form can easily be seen from the cut. The cross is about 6 feet high, and is made of English ivy leaves of a very dark green, while the crown is composed of white carnations; the flowers below are hydrangeas. The spray that runs up the cross is made of silver, and is set with minute frosted incandescent lamps, which it will be seen are used elsewhere with very pleasing effects. The current is supplied from the Edison Twenty-sixth street station, and the decorations, which are very handsome and effective, were the work of the Edison company.

## Rapid Transit in New York City.

At a meeting of the Rapid Transit Commission held on Saturday, April 8, 1893, the underground capitalist of which much has been heard of late finally materialized. Two communications from the banking house of R. T. Wilson & Co. were read, which outlined pretty definitely the propositions which the capitalists were prepared to make in regard to the construction and operation of an underground railroad in New York City. The first, bearing date of April 1, after expressing the belief that a system of underground road would better meet the requirements of rapid transit in New York than any other that could be devised, made the following suggestions: First, the organization of a company with a cash capital of $15,000,000 to construct and operate an underground road in the main following the route laid out by the commission. Second, the city to loan its credit to said company to an amount equal to 70 per cent. of the actual cash cost of the property; the amount, however, to not exceed $35,000,000, and the city to have a first mortgage lien upon the property and franchise of the company. Messrs. R. T. Wilson & Co. stated they were ready to assume the responsibility of procuring $15,000,000 upon these conditions:

The second communication was dated April 7. It stated that after consultation with their counsel, Messrs. Evarts, Choate & Beaman, it was found that a provision of the constitution of the State of New York prevented the city of New York from using its credit in the manner proposed. To overcome these difficulties Mr. R. T. Wilson, of the company, proposed that a corporation of a cash capital of $15,000,000 be formed to build the road, the city paying 70 per cent. of the actual cash cost of the same in bonds at par, upon the condition that the city will contract to sell to said corporation or to another corporation the railroad after it shall be built. If this plan should not be satisfactory it was suggested as an alternative that a corporation be formed to purchase a franchise under which it shall build, own, and operate that part of the proposed route from the Battery up Broadway to Fourteenth street, including the loop to the Brooklyn Bridge, upon the condition that the city shall build the rest and sell to the corporation.

In rapid transit matters, according to the act under which the present commission exists, the veto power of the Mayor of New York City is absolute, and, therefore, his views upon the subject were awaited with considerable interest and were expressed in the following words:

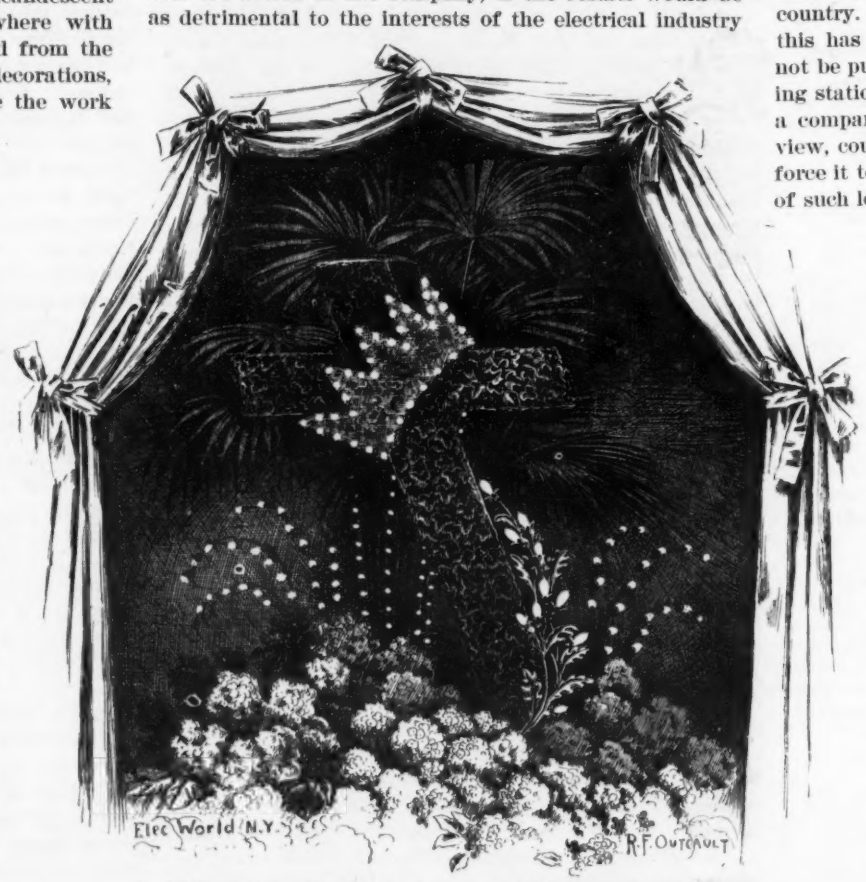
"I might as well say right now and once for all, and this may save the Rapid Transit Commissioners a good deal of trouble, that I shall never approve any plan which they may formulate or any plans which some one else may formulate and which they may present which contemplate the expenditure of the city's funds or the lending of the city's credit."

## The Incandescent Lamp Situation.

The following communication has been received from Mr. F. S. Terry, manager of the Ansonia Electric Company, of Chicago:

*To the Editor of The Electrical World:*

Sir: I have followed with considerable interest the correspondence which you have been publishing during the last few weeks on the incandescent lamp situation, and while my letter to you, which was used to bring out this correspondence, was not written for publication, it has perhaps served a better purpose than I intended. In attempting to give my own views on this subject I find myself in a somewhat embarrassing position, owing to the fact that all of my business interests are directly opposed to those of the so-called "Trust," but I will endeavor as far as possible to consider only the electrical industry as a whole, and what would contribute to its greatest improvement and economy. If I am as fair in my views as I would wish to be, they would not be changed whether I was connected with the General Electric Company, or the interests with which I am associated. The first question suggested by me in my former letter was: "Is it possible for the General Electric Company to obtain control of the lighting industry?" Most of those who have answered have given reasons why such a result is not probable; for instance, Mr. Leonard states that no such result is "likely to be possible." I appreciate that the difficulties in the way are such as to make final success in that direction not probable, but I believe that such a result is quite possible. Assuming that there is but one chance in a hundred that the control will pass into the hands of one company, if the results would be as detrimental to the interests of the electrical industry as I now believe they would be, the present situation, in the absence of definite decisions regulating and limiting the use that may be made of patents, may well be considered serious. Were we to find ourselves in the company of 100 men, one of whom we knew would be shot, we would certainly consider the situation serious.




ELECTRICAL DISPLAY IN A FLORIST'S WINDOW.

It is probably that new lamps that will be held not to infringe the Edison patent will shortly be placed on the market, but to give relief to the situation such lamps must be fully equal in quality, if not superior, to the Edison lamp. Decisions may be rendered limiting the use that can be made of the patent, or it may be found that the organization and business policy of the General Electric Company are in violation of the anti-trust laws. None of these things, however, at the present time, is an established fact. The decisions so far rendered, as I understand them, have been entirely in favor of the Trust interests, and not only have not limited them in the use that they could make of their patents, but, as it would appear, have rather leaned in the opposite direction, and have contained intimations that the patents might be used for any purpose whatever; as for example, either be locked up and not used for the benefit of the public, or to be used to control the sale of other apparatus not covered by patents. Up to the present time interest has centred mostly in the incandescent lamp patent, but there may be other decisions of equal or greater importance. Recently a decision favorable to the Edison interests has been rendered in the feeder and main patent, and there are other lamp patents and socket patents that are still to be decided.

The question is often asked; "How long before the expiration of the Edison lamp patent?" and many are satisfied to believe that they need only wait until that time when all restrictions will be removed. They entirely forget the other patents which may be combined and strengthened in such a way as to control the industry long after the first patent expires, as, for example, the Edison flashing patent, the three-wire patent, and many other subordinate but essential patents.

A lawsuit is as practical a question as the sale of goods. There is no such thing here as absolute justice, and more will depend upon the ability with which a case is handled than what is actually right or wrong, and in considering the control of the lighting business by the General company we should not overlook the ability of Mr. Coffin and Mr. Fish. They have the ability to overcome their difficulties and obtain the results they desire, and where others would fail they may succeed. Up to the present time the General Electric Company itself has been careful not to antagonize, simultaneously, too many interests, so as to bring upon them united opposition. They have not in all cases refused to sell lamps for use with other dynamos, although as Mr. Fish states in his interview they have supplied these lamps in such a way that it could not be considered a precedent for the future. With all the lamp factories closed the situation would be somewhat different, and the General Electric Company could afford to be more independent so far as other dynamo manufacturers are concerned, and it would be even possible to continue right along to sell lamps to other manufacturers, but send them lamps of such efficiency or quality as to make it impossible for them to compete with the apparatus furnished by the General company; and, while it might prove a difficult thing to do, it would not be impossible for the General company, with its extensive capital, to gradually obtain control of the majority of the paying central stations throughout the country. Probably few are aware to what an extent this has already been done. If a central station could not be purchased on satisfactory terms a smaller competing station might be established, which, when backed by a company with large capital and a direct purpose in view, could depreciate the value of the old company, and force it to almost any settlement desired. The franchises of such local companies are capitalized for large amounts by the General company; bonds are issued and a large profit realized without rendering any equivalent to the General company every day.

Great improvements have been every year made in electrical apparatus, lowering its cost and increasing its efficiency, thus reducing the cost of electric lighting so as to bring it more within the reach of all, and adding to the value of electrical investments. Most of these improvements are the direct result of competition, and to the final benefit of the public. Without competition, the incentive for improvement would be gone. Whatever may now be the intentions of the General Electric Company, should they obtain control of the lighting industry, is not of importance at the present time, as we should all understand human nature well enough to realize that its policy might be a selfish one and in the direction of increasing its own power and profit even at the expense of the public. Such a result at least would not be surprising.

The General company is undoubtedly entitled to the profit on the patents it owns, but I do not believe that it is equitable or just, nor was it the intention when the patent laws were framed, to permit the use of one patent to obtain a profit for a whole system or line of goods, far more than could be legitimately earned in the sale of the goods covered by the patent, nor do I think that it was ever intended that a patent should be used to create a monopoly in direct opposition to the interests of the public.

The peculiar use that is being made by the General Electric Company of its patents and the result it seeks to obtain are almost new. The Bell Telephone Company is often referred to as a parallel case, but between the two there are some very important distinctions. There has not in the past been the same opportunity and necessity to consider the question of public policy in making decisions in patent litigations, but undoubtedly such decisions must shortly come, and what such decisions will be will largely depend upon the circumstances under which they are brought about.

I have tried to show some reason why all of us who are interested in the success of the electrical industry might well be interested in the patent situation. It is not altogether a question as to whether or not the lamp factories are closed, or whether it affects the interests with which some of us as individuals may be connected. Nor is the question necessarily connected with one patent more than another, but it affects them all equally, and whether or not it will be possible for the General Electric Company to control the electric lighting and possibly the other electrical interests of this country, will largely depend upon the decisions that will be rendered within the next year or two showing what kind of property a patent is, and what privileges the ownership of a patent may give.

F. S. TERRY.

## Municipal Electric Plant in Berne, Switzerland.

The city of Berne, one of the most important cities of the Helvetian Confederation, and always progressive in introducing modern inventions, was one of the first cities in Switzerland to introduce the electric light.

The water power of the River Aare, which in this city has a maximum fall of three metres, representing

FIG. 1.—CONNECTION BOX.

about 400 h. p., was at the disposal of the town as a cheap source of power for the electric plant. The power house is erected over the canal, which was built for the purpose of utilizing this valuable water power. Three turbines of 120 h. p. each are in use, two for driving the dynamos, while the third is used for tramway purposes and drives a system of Mekarski compressors made by "Les Ateliers des Constructions Mecaniques de Vevey," which are situated in a neighboring building.

The three turbines transmit the power, by means of beveled wheels, to a common shaft which makes 125 revolutions per minute; on this shaft are fastened pulleys of 2.5 metres diameter, which serve for driving the dynamos. A spur wheel transmits the power from the shaft to the compressors. The shaft making 125 revolutions can be uncoupled by means of a claw coupling, so that each turbine can drive independently of the others. The Jonval turbines are regulated by three crown-shaped inlets, of which only the outside one operates at low water. The regulation of these wheels can be effected either automatically or by hand. The hydraulic plant was installed by Th. Bell & Co., in Kriens. The electrical plant consists of six-pole dynamos of the Oerlikon Co., one of which serves as a reserve; also of a battery of accumulators made by the Oerlikon branch of the Hagen i. W. works, and of the necessary measuring instruments, switchboards and apparatus for regulation.

The dynamos are of the best construction and finish, and have all desirable qualities of a light machine to a high degree; the insulation of the armature windings is very high, and the winding is such that the neighboring layers never have the full voltage; it is fully protected against external injuries. The machines of this type are proportioned so that the voltage can be increased considerably by the regulation of the shunt magnets, and then they are also very well adapted for charging and running in connection with accumulators.

The machines for this plant were originally constructed without reference to the increased voltage which is necessary for charging the accumulators, because it was not intended at the start to use accumulators. They have six poles, and three pairs of brushes, and at 450 revolutions give 120 to 140 volts, and 84 kilowatts; their large commutators run absolutely without sparking, and after

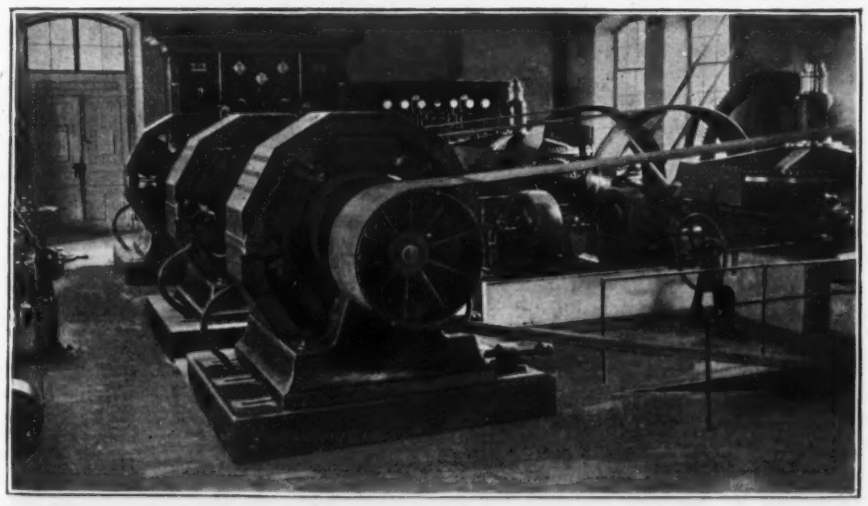


FIG. 2.—THE DYNAMO ROOM.

two years of use show almost no signs of wear. The accumulator battery is placed in a special building near by (see Fig. 5), which is very well ventilated. The battery consists of $2 \times 72 = 144$ Tudor cells number 19 of the accumulator works in Hagen i. W.; of these $2 \times 16 = 32$ can be switched in and out for regulation purposes. The battery has a capacity of 690 ampere hours.

The plant is run with the three-wire system, and is for this purpose arranged as is shown in Fig. 3; I. and II. are the machines which run continually; each of them can be replaced by the reserved machine R by means of the switch u. The two batteries are generally charged in the daytime, and the charge is stopped when the lights begin to be turned on. For charging they are connected in one row in order to obtain the increase in voltage over that of the reserve machine Z, which is drived by the motor M. The charging current is 175 amperes, to which the reserve dynamo has to contribute about 100 volts. But it is also possible, as is shown in Fig. 3, that each of the batteries can be charged separately in case one should have been discharged more than the other; this is effected by means of the switches $U_a$ and $U_b$. Simultaneously with this it is posssible to generate the necessary current consumed outside of the station. During the discharge of the batteries with a maximum current of 270 amperes, they are in multiple arc with the dynamos, and either assist the machines or supply all the current alone, which latter generally takes place after midnight. The regulation of the voltage is in both cases facilitated very greatly by the automatic switch for connecting and disconnecting individual cells.

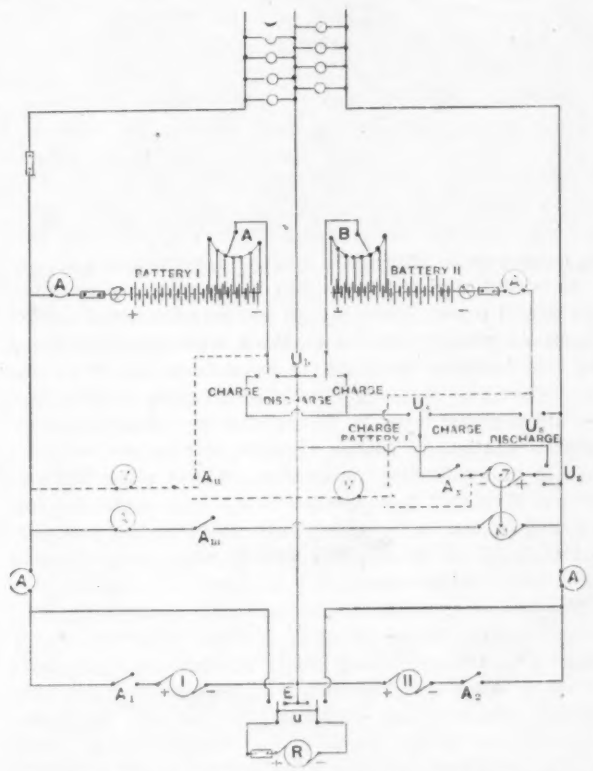



FIG. 3.—DIAGRAM SHOWING BATTERY CONNECTIONS.

In this automaitic regulating switch there is a relay, which is connected to two points of the system. If the voltage drops too much, then the movable core of the relay makes contact with the lower contact screw. If, however, the voltage is too high, then the core is raised, making contact with the upper contact screw. By means of these contacts the circuit is closed through one or the other of the electromagnets of the switch, which in turn close the circuit of one of the electromagnets of the multiple switch for the individual cells. The latter then attracts its armature, on which there is fastened a tooth, which then gears into a spur wheel which in turn operates the contact lever fastened upon its axis. One complete movement of the armature corresponds exactly to the movement of the contact lever from one contact to the other. If the core is drawn in completely, the circuit

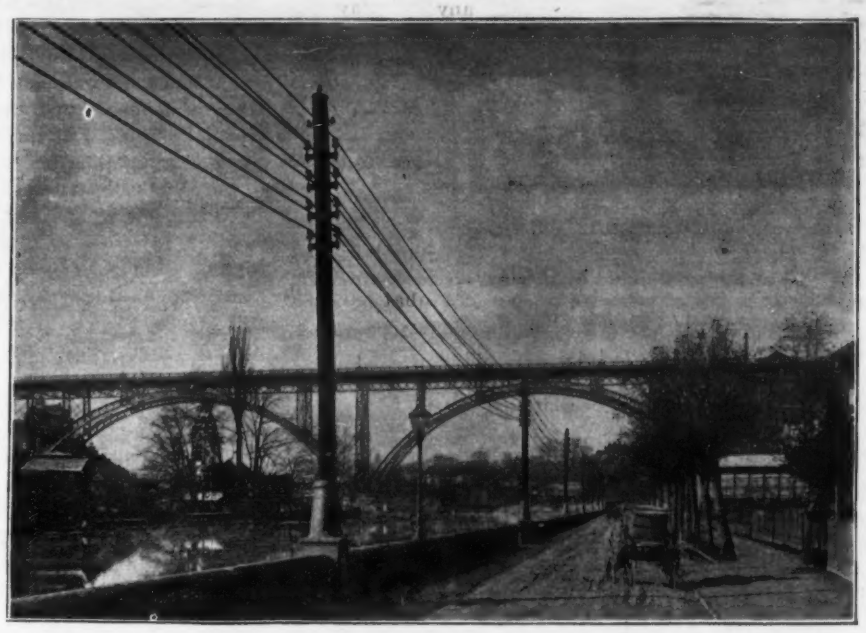


FIG. 4.—OVERHEAD CONSTRUCTION ALONG THE RIVER AARE.

for the small electromagnet is broken; the magnet ceases to act and breaks the circuit of the main magnet. In returning to its original position the core again closes the open circuit of the small magnet again and in case the relay has still other contacts to close, that is, if the tension is not yet the desired one, the action will be repeated. When the contact lever reaches the end position on the switch for the cells, the circuit of the small magnet is likewise broken. The apparatus operates sufficiently quickly to prevent the variations in the loads from being noticed in the lights.

At present the capacity of the plant is the equivalent of 3,000 incandescent lamps of 16 c. p. The circuits consist of three pairs of feeders, two systems of compensation wires and what is termed a "ring" or closed network of mains. The line wires are overhead along the River Aare, from the station to the Muenz Terrace, a distance of 800 metres. They consist of six cables of 325 square millimetres, and two of 250 square millimetres cross-section; besides these the poles contain the pressure wires which lead back to the relays. This construction, shown in Fig. 4, deserves to be called a work of art. Every 30 metres the balustrade of the quay is strengthened by a stone support upon which rests the cast iron base for the mast which has a diameter of 300 millimetres; the masts are six metres high, and are provided with oil insulators which are fastened to wrought iron bell shaped fixtures. The cables themselves are strung with so much care and taste that, notwithstanding the great weight, the whole has a pleasing rather than a displeasing effect, and is looked upon as one of the sights of the city.

On the Muenz Terrace, the overhead cables pass down through a brick conduit into the ground. At this point switches make it possible to break the circuit of each cable to test it. For protection against atmospheric discharges there is a lightning rod for each overhead cable. The underground cables, which are distributed over the whole town proper, consist of Berthoud-Borel lead cables in impregnated wood boxes. The connections to the main cables, as well as those for the public arc lamps, are made in boxes like the one shown in Fig. 1. These boxes contain lead fuses and switches for every connection. The lower part of the box is filled with

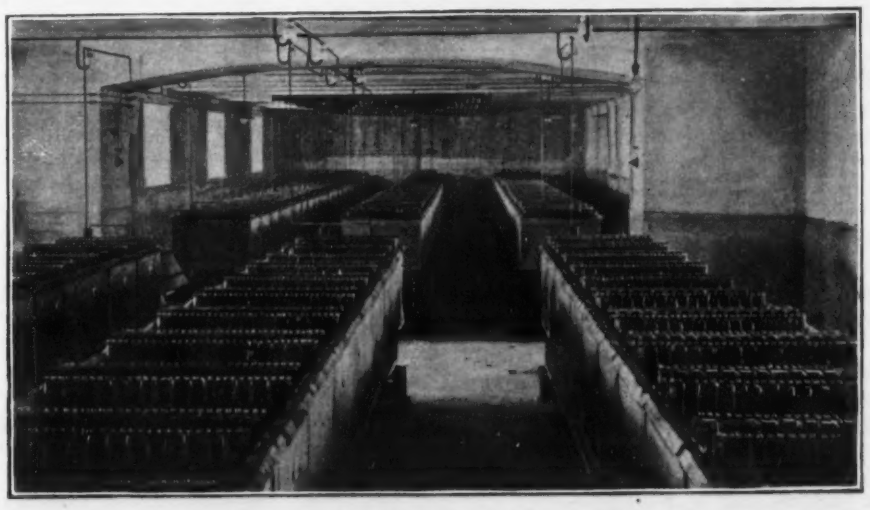


FIG. 5.—BATTERY OF ACCUMULATORS.

an insulating mass. The boxes are located at nearly every corner of the streets, and as they are so handsomely fitted up they do not form an objectionable feature. For making house connections a standard type of cast iron boxes, with three sections, is used; they are at the same depth as the cables.

The public illumination is effected by means of 30

Kritzik arc lamps, of which sometimes four, sometimes two, are in series. Some of the arc lamps are fastened to candelabra, some to masts, while others are suspended from wire simply drawn across the street. Among the installations in this city the one in the railroad station deserves special mention. In this there are 50 arc lamps of 10 amperes each, which are running without any reserve. The confidence in this municipal electric light plant has so far been fully justified by the results.

## On the Rotary Magnetic Field and Multiphase Alternating Current Distribution.

BY LUDWIG GUTMANN.

In the last few years a great deal of attention has been given to the rotary magnetic field, and a review of the principal workers and their devices may be of special interest. In 1885 we find the alternator almost forgotten. It had been abandoned and was found only in laboratories, but otherwise it had hardly any but historic interest. Very rarely such machines as the Ferranti-Thomson, for incandescent lighting, or a Siemens alternator, for either arc or incandescent work, were met. The continuous current machines monopolized the market. They were the only salable devices for commercial lighting, when, unexpectedly, the great prize of the Turin Exposition of 1884 was awarded to Mr. Lucien Gaulard, of Gaulard & Gibbs, London, an eminent French physicist and chemist, for a distribution over long distances, by means of transformers and alternating currents. This result drew the attention of engineers again to the alternating current generators and high tension distribution, especially as it had been found meantime that, commercially, there were great obstacles in the distribution of low tension continuous currents over great areas. From this time on a great many engineers began to experiment and design transformers, as, for instance, Deri, Zipernowski, Ferranti, Siemens, Hopkinson, Kennedy, Kapp, Mordey and also the writer, who at that time was with Messrs. Gaulard & Gibbs. Among the early workers in America was Mr. Stanley.

It was in the early part of 1885 that Prof. Galileo Ferraris was engaged in testing the efficiency of transformers made by Gaulard & Gibbs, as also those of Ganz & Co., which tests were completed in July of that year. During these experiments the fundamental and far-reaching principles of the rotary magnetic field were developed, which were verified by experiments within the two following months. This eminent scientist did not make a secret of his work of obtaining rotation by alternating currents; on the contrary, he showed the devices and experiments, during the latter part of the year 1885, to many prominent workers, such as Mr. Gaulard (London), Mr. Deri (Budapest), Prof. von Beetz (Munich), Prof. G. Mengarini (Rome), Mr. P. Bellani (Italian representative of the Thomson-Houston Company), and many others. Before that time but a single alternating current had been used and studied, and little was known about it. Here, however, the action and laws of two alternating currents were explained and shown by experiments, which are now familiar to every student in the alternating current field. Prof. Ferraris produced his currents of displaced phase by means of converters; but was this clear sighted man ignorant of the fact that the difference in phase could not be accomplished by any other means than those adopted by him? By no means. He had intended to make modifications by building a generator producing currents of displaced phases and larger motors to be operated thereby, but he had been prevented, partly by reasoning, partly by circumstances.

We have here a similar case to that of Prof. Henry. Working in a scientific laboratory, with its limited means, no changes could be attempted with the Siemens alternator, as the winter term had just begun, and the machine was needed for other work by the students; besides, he was perfectly clear in his mind that the application of special designs of generators and the consequent complication of feeding wires would be a great practical inconvenience, which would tend to complicate the system, and considerably reduce its scope and utility. In spite of the advancements made in recent years, he still now maintains the same view, that the motor to solve the problem should be operative on the present systems of two wire distribution. These considerations, more than any others, may have influenced the professor to delay such special modifications and to produce the rotary magnetic field by the simpler methods within his easy reach in using a transformer or derived circuits. The delay of communicating these experiments to the Royal Academy or otherwise publishing these results for almost three years was due to grave private misfortunes, or troubles, which influenced his mind for a considerable time.

As the transformer system developed during the next few years, the need of a meter made itself felt, and we read in 1887 (I think) in English periodicals remarks to that effect, the Ferranti meter being then but little known and less used. Suddenly the great and slowly progressive work was interrupted by the communication of Prof. Ferraris, on March 18, 1888, to the Academy of Science at Turin, of the laws and actions of his "electro-dynamic rotation by alternating currents," which stirred up all constructing engineers, and brought new life and increased vigor for investigations in this unexplored field.

The publication was soon followed by translations in electric periodicals all over the civilized world. The first appeared on May 18, 1888, in the English "Industries," edited at the time by Mr. Gisbert Kapp. Since then this paper, owing to its extreme simplicity, clearness and importance, has now appeared so often in one form or another that we need not go over the ground once more at this place.

Ferraris' "electro-dynamic rotation" can be condensed into the following short sentence: "Rotation of a magnetic field is the resultant of two or more magnetic or magnetizing forces of variable intensity acting at an angle to one another, whose maxima do not coincide, but whose periods are the same."

Two months later Mr. Tesla described his motor built on the same principles. We have here a great contrast: On the one hand a scientist in a great city of Italy, with limited means, and his only purpose, knowledge, light; on the other hand we find a young experimenter, backed by considerable capital, located in the busy metropolis, New York, where the chief motto is, "Time Is Money," and the principal aim "Dollars and Cents." The object, after having found rotation independently, was to get returns for the experiments by making commercial motors.

The respective characteristics are fully embodied in the important work of these distinguished workers. Prof. Ferraris lays down in beautiful and simple language the fundamental law governing this class of machines, while Mr. Tesla explains the action in his own way, which is not fundamental, but builds machines for practical purpose.

While these two men are the most prominent workers in this field, we have also to consider the work of others. Here we have to name first Mr. Bradley, who obtained a patent for a simple generator in October, 1888. It may be called a universal machine, inasmuch as it can be used as a continuous current generator or for alternating or multiphase currents. However, no statements are made in this patent that he expected rotation, or wished to operate motors by two or three alternating currents of displaced phases. This machine, which may be destined to do before long much valuable service, remained unknown to many, even to American workers, especially as there was no immediate demand for the same.

Naturally after a new subject is thoroughly understood we would expect some one to come to the front with a claim of priority, and sometimes with apparent right. In this instance such claims have been raised by the French engineers, M. de Fonville, M. Lontin and M. Marcel Deprez, and later M. Hasselwander, all of whom obtained rotation by either alternating currents or alternating and pulsating or continuous and pulsating currents. However, the question is not who made the first apparatus, but who understood first the subject, the principle of the device, and who in consequence thereof most benefited the world.

For instance, we name for historical reasons the first attempts in dynamo building, but the credit for fundamental and far-reaching work belongs to much later workers, such as Faraday, Hopkinson, Frohlich and Kapp. Similarly in this case, some early inventors may have built motors or small contrivances which produced rotation, but their work remained unnoticed, because the fundamental principle was either not understood by them or did not receive the deserved prominence. It can hardly be said that it was a fault of the time, because the subject has not been in advance of developments, as in those days we know that arc lamps, and later incandescent lamps, were fed directly by alternators, especially of the Siemens and Ferranti types, and power transmission would have been attempted if there had been motors, or at least if the principle on which these early devices had been built had been understood.

It is therefore no surprise that the work of Prof. Ferraris, when explaining rotation by alternating currents in simple language, and based on principles so familiar to us, should sweep like a cyclone over all the civilized world. It is this work which made the understanding of the Tesla motor so simple. The explanations given by Mr. Tesla are as fundamental. However, the criticism by some English workers in their periodicals is often unjust, and based on observations or conclusions derived from a single diagram or a single patent or paper, and consequently erroneous. The writer himself agrees in many respects with Mr. Kennedy; however, he believes that the criticism is too severe, as it is far easier to improve on the fundamental work of others than to do fundamental work oneself. Besides, only the first of Mr. Tesla's patents are based on the production of rotating the magnetic field. There are, however, enough other ones granted, at least in America, which speak of energizing fields, magnets whose poles, or what is the same, whose magnetic flux, do appear at different times without limitation to rotating fields, as Mr. Tesla himself has shown such magnets in parallel planes, instead of in one single structure.

As regards priority, Prof. Ferraris has the earliest publication and is recognized by most civilized nations as the father of the rotary magnetic field, and even should Tesla's applications for patents be taken into consideration, then, to be just, we would have to consider the unsolicited testimony of engineers like Mr. Deri,* which would give Mr. Ferraris the right to go back to 1885 and Tesla to 1887. However, it is thought that publications only can be looked upon as just, as the main point to be considered at all times is, when the public first was made acquainted with a certain development and derived the benefit therefrom.

However, there is sufficient and distinct merit in the work of either scientist. While Prof. Ferraris is the father of "electro-dynamic rotations," Mr. Tesla is the father of the system of distribution by multiphase currents and its applications.

However, in spite of the many weak points which exist at present in the rotary magnetic field, this principle has not been discovered nor this system of distribution been invented simply to be shelved. They both have come to stay, to form their department in power transmission.

The motor is open to improvements, and so is the system, and therefore Mr. Kennedy's statements must be read with reserve, because the case is by no means as hopeless as he describes it. It is only strange that Mr. Kennedy himself has a use for multiphase currents and combines a number of known devices into a system for commercial distribution. In a recent publication he rejects as hopeless everything else except multiphase currents, and instead of using a Tesla transformer he uses three separate converters, where a slight originality is gained at the expense of 25 per cent. more material.

No doubt it is unpleasant to see that a fundamental worker wishes to have all the glory and ignores the work of others necessary to make more economical machines, but this should not influence us not to fully recognize the importance of his work, even if we can devise a multiphase system without using transformers and not covered by his patents, as by their original design, their merits, or the meritorious results to be accomplished, have been brought to the notice of others.

Mr. Kennedy may abandon the use of a single alternating current for such distribution; others, however, will not do so, but will make use of single phase alternators of a safe potential, feeding by means of transformers high tension alternating currents from a distance into sub-stations and supply, aided by storage batteries, currents required for the devices in use at the locality, either low tension, continuous, alternating or multiphase, or all three if necessary. There is no doubt about it that to-day we can derive from a single alternating current all the various forms of currents; but however grand this distribution may seem, it is too complicated. We need simplification and not complication; therefore we should not strive to accommodate all apparatus now manufactured into one system. The solution lies in a simple alternating current motor. In this field there is an enormous scope, so wide even that in spite of the broad Tesla patents he must accustom himself within a year or two to find motors with a rotary magnetic field not covered by his patents, and some dozen other motors, with and without condensers, adapted to accomplish the same results far more economically than the original Tesla motors. To attack this question successfully, it is necessary to know the whole work of others, then devise other means as original, simple and far from their ideas and work as possible. Having accomplished the building of alternating current motors similar to the continuous current series and shunt motors, we will find the continuous current motors soon restricted to isolated plants, while multiphase or other complicated systems will stand on the level with continuous current distributions.

## Magnetic Clutches.

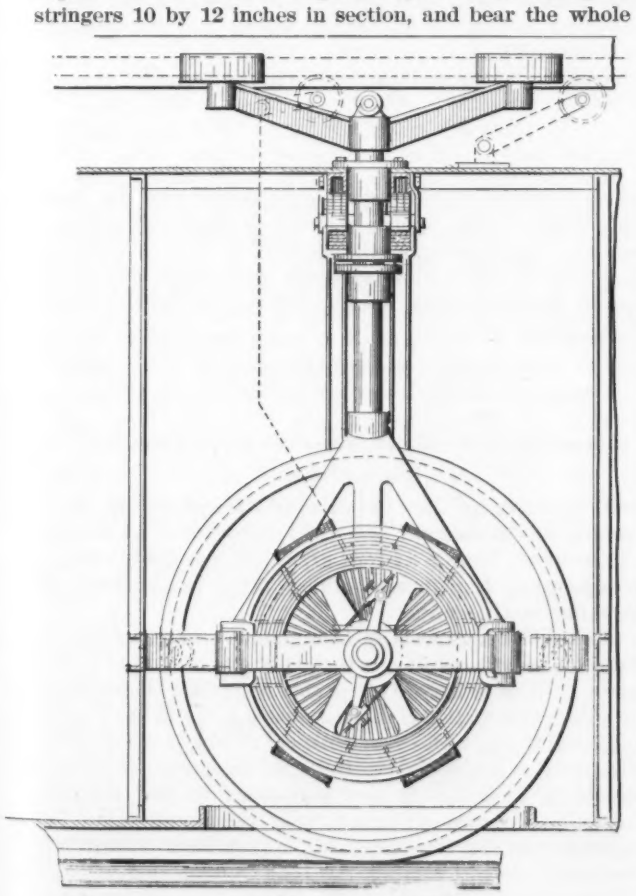
The application of the electric clutch to the propulsion of river vessels was briefly described in The Electrical World of March 11, 1893. In this connection it may be stated that this device is not unknown in this country, and Mr. E. Harrington secured a patent here after a long interference with Mr. T. A. Edison. In a recent letter he states that experiments in this direction were of the most satisfactory character. This method of transmission was used to run the machinery in the repair shop of the Atlantic City Electric Railway Company, in place of the regular leather belting. The Midgeley flexible spiral wire belting was employed, running very loosely over oiled pulleys. This method is peculiarly adapted to all forms of power transmission where a smooth, positive motion is required and where sprocket chains and gears would otherwise be necessary, as well as in all cases where crossed and straight belting is employed alternately. A single change-over switch is all that is required to operate this belting, thus doing away with friction clutches and other cumbersome mechanical devices.

* See Transactions International Congress of Electricians at Frankfort-on-Main, 1891.

## The Boynton Electrical Bicycle Road.

A NOVEL experiment is to be tried on Long Island, some 50 miles from Brooklyn, in the near future, which consists of the operation of an electrical bicycle road over a track some one and a half miles in length already constructed. While this is an experiment in one sense of the word, it is not an experiment with an entirely new device, for, as the public are aware, a bicycle road operated by steam has been running for three years past between Gravesend and Coney Island. The present road, however, will be the first upon which electricity has been used as the motive power, and while the bicycle principle has been tested to the satisfaction of its projectors at Coney Island, still many changes were required in the motor arrangements to adapt them to the uses of electricity. These changes have, however, been in the direction of simplification rather than complication, and the opening of the new road will be awaited with interest by those who are conversant with this new departure from familiar types of electrical transportation. The accompanying diagrams together with the following description will make the plan to be pursued clear.

As indicated by the title, the car runs upon two wheels placed fore and aft as in the familiar bicycle of the day. These wheels, five feet in diameter, are double flanged, making a groove on the circumference 1⅛ inches in depth. These run on a single heavy iron rail resting on stringers 10 by 12 inches in section, and bear the whole



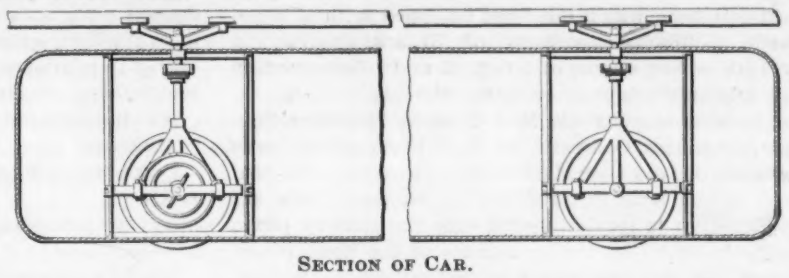
SIDE VIEW OF MOTOR.

weight of the car. Directly over this rail, at a vertical distance of about nine feet, are suspended the guide and trolley rail. The former consists of an inverted wooden trough, in the channel of which is fastened an iron rail, 12 pounds to the yard, which does service as conductor for the current. These trolley rails are doubly bonded with number 4 B. & S. copper wires, which are bent at their ends at right angles and inserted into holes in the ends of the rail. A conical steel plug having a circular slot cut into it longitudinally, of the diameter of the bonding wire, is then inserted into the hole and around the end of the bonding wire and driven firmly home by a few blows of the hammer, thus insuring perfect electrical contact as well as firm mechanical junction. This method of fastening the bond wires is considered superior to the usual method of riveting in that it can be accomplished in a minimum of time and can be readily tightened up when required and permits of the withdrawal of the wires by a blow on the plug in the reverse direction. The trolley wheel itself, which rests on springs connected rigidly through an upright bar to the truck beneath, has a perfectly flat bearing surface instead of a groove as is usual.

The vertical outer surfaces of the inverted trough serve as bearings for the guide wheels, four in number, which constitute a part of each trolley. These guide wheels are each 12 inches in diameter, are made of wood and have rubber tires and are arranged in pairs, the two forward wheels and the two rear wheels spanning a distance of 5 feet, which is exactly the diameter of the driving wheel beneath. This upright shaft, which supports the trolley wheel or brush and four guide wheels, consists of a wrought iron tube 6½ inches in outer diameter and 6 inches internal diameter. At its lower end it fits into a fork which spans the driving wheel and terminates in bearings resting upon the axle. Near its upper end it passes through a hole in the car roof. In each car there are two of these shafts similarly arranged one at either end, and the car is flexibly suspended to this shaft at each end through two springs which permit of angular motion of the car or shaft through roller bearings between a lug fastened to the shaft and another fastened to the springs. In the accompanying vertical section through the motor and driving wheel the armatures are represented as exterior to the prongs of the fork spanning the driving wheel. But in the latest design the motors will be rigidly attached directly to the driving wheel one on either side, and will be embraced within the span of the before-mentioned forks. The field magnets will be interior to the armature, and will be stationary; there are six poles to each field, but the coils of the armatures are cross connected so as to require but two brushes to each armature. The armatures are 45 inches in diameter and are wound with two layers of number 7 B. & S. wire, each containing 596 turns. They are of the closed coil type, and the two are connected up in series with each other. This makes an exceedingly compact motor, as it is but 18 inches in width and has a capacity of 75 h. p. running at 560 revolutions.

The truck frame to which the driving gear is attached is entirely independent of the car, and is kept central by means of four vertical guides which are themselves rollers revolving in a horizontal plane. These bear upon four horizontal roller guides revolving in vertical planes, thus permitting of motion of the car or trolley shaft either vertically or horizontally independent of each other. The springs before mentioned by which the car itself is supported, take up the jar and vibration of the car and the independence of the rolling gear from the car relieves the trolley brush of the vibration of the car itself.

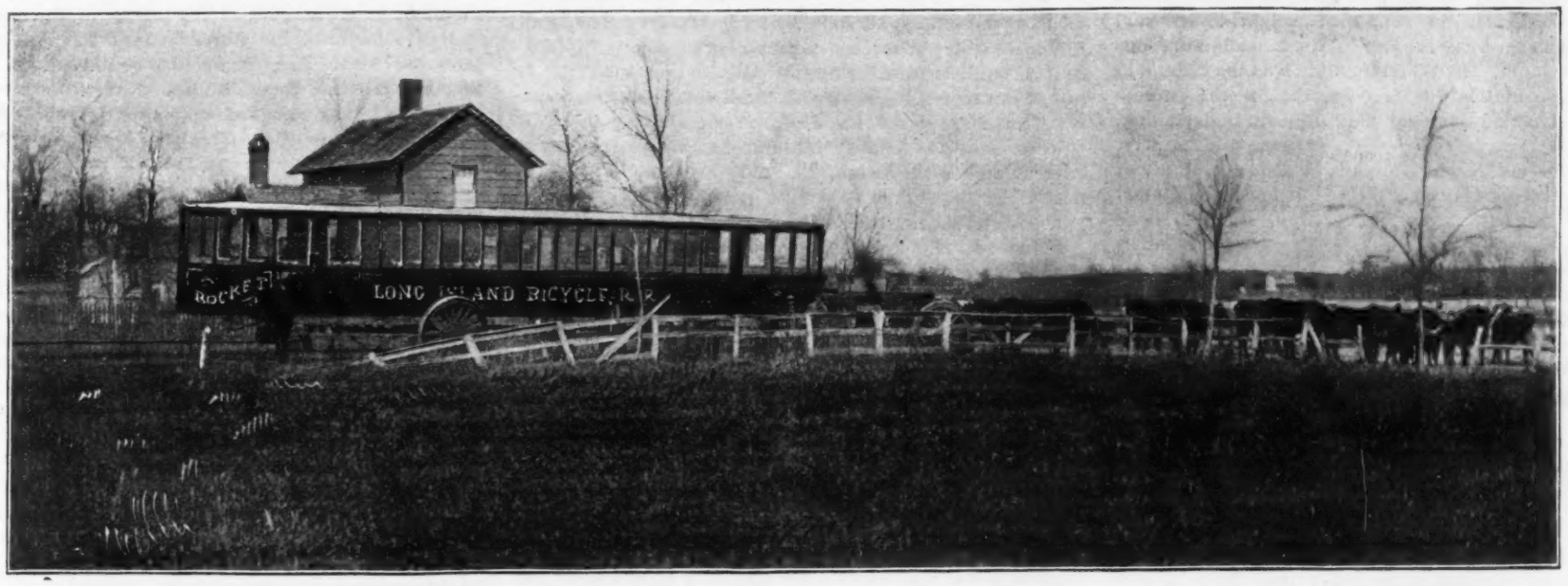
In the cuts which accompany this article the electrical contact with the trolley wire is represented as a wheel and so described heretofore, but in the present equipment this is to be replaced by a brush or brushes consisting of flexible soft steel plates extending vertically upward from a spring attached to the trolley shaft. The flexibility of the brushes together with that of the spring, it is thought, will be sufficient to permit of all the vertical play required in actual practice, 2½ inches being thus provided for. In reversing the motion of the car no change of the trolley connection is required, as the flexible brushes will readily adjust themselves to the changed conditions, and, in fact, the whole arrangement of the trolley is such as to insure its contact with the conductor at all times and to render its leaving the conductor unintentionally an impossibility, and to render its intentional removal in ordinary practice unnecessary.



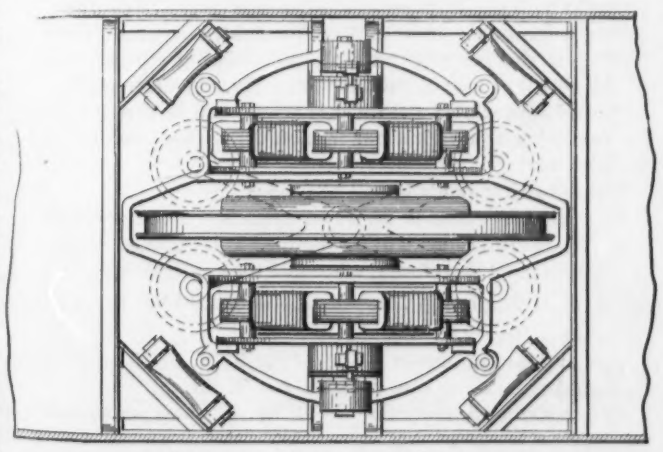
SECTION OF CAR.

The substitution of the sliding contact for the rolling contact was deemed essential for high speed, and it is intended as soon as this road is completed to attain these high speeds, and 100 miles an hour are thought to be easily attainable by this method. In passing curves in the track the double flanged wheels will always be tangent to the curve at its point of bearing, and as this wheel turns the trolley shaft will be turned with it, thus throwing the guide wheels always in line with the horizontal diameter of the driving wheel and keeping the brush or sliding contact always central over the bearing point of the driving wheel on the track below.

As in steam practice the centrifugal force due to changing directions will be opposed by the lean of the car, and in such cases the trolley rail and guides will form a curve of lesser radius than the track curve, and unusual strains due to thrusts of this kind will be readily obviated. It is believed that in this manner another of the great obstacles to extreme rapidity of motion has been successfully overcome. In the car which has just been constructed and christened "The Rocket" but one motor will be employed. This car weighs 3½ tons and is 65 feet long, 4 feet wide and is divided into six compartments, each containing two double seats and capable of seating four people conveniently. Each compartment has a separate door of its own on the same side of the car, and these doors are controlled by the conductor so that they may be simultaneously opened or closed from his end of the car. Unlike the compartment cars abroad the partitions extend only high enough to support the head of the passenger and from that point to the roof the car is open and an unobstructed view and ventilation is attainable from end to end of the car. Thus, while securing all desirable privacy, the sensation so objectionable to the independent American citizen of being locked in




THE BOYNTON BICYCLE CAR EN ROUTE TO HAGERMAN, L. I.



PLAN OF MOTOR FROM BELOW.

apart from others of his kind is not felt, and the conductor may be signaled from any compartment as readily as in the ordinary street car. The present road, of which as before said about a mile and a half is ready for operation, is a link in the chain which it is intended to extend between the sound and the ocean running through Belport and Hagerman. This is a distance of about 20 miles, but before this is completed it is intended to ex-

tend the line from Hagerman to Brooklyn, a distance of 55 miles, and surveys and negotiations for right of way to this end are already under way. At Hagerman a power station has already been erected for the initial link of this road, which has been equipped with a Westinghouse multipolar generator of 75 kw. capacity, a New York Safety engine of 100 h. p. and tubular boilers of the locomotive type.

For various reasons the New York & Brooklyn Suburban Investment Company, of New York, which owns large tracts of land near Hagerman, and which is the real backer of the scheme, preferred to transport this car from Brooklyn to its destination over the country pikes, to intrusting it to the tender mercies of the Long Island Railroad. To this end they procured an enormous four-wheel truck, upon which the boat shaped car was placed, and to this they attached fourteen yoke of oxen, and on Tuesday, April 4, at 9 a. m., pulled out upon their journey through the wildernesses and impenetrable forests and jungles of the great Long Island. Many were the adventures and mishaps that were met, and many the amusing, if not trying, incidents encountered. The country bridges, of which there are many, which span the numerous streams putting into Great South Bay, were some of them constructed to bear no heavier burdens than a well filled hay wagon or a drove of cattle. When it is understood that the combined weight of car and truck was thirteen tons, the difficulties in such situations will be appreciated. Mr. W. H. Boynton was the general in charge, and to him is due much credit for the success which has attended thus far this difficult undertaking. Although the car left Brooklyn at 9 a. m. Tuesday, April 4, it did not reach Wautagh, a distance of about 25 miles, until Thursday at 3 p. m. It had been stalled at Freeport for half a day Wednesday, and had been stuck in a swamp for another half day about two miles west of Wautagh. Our illustration shows the train as it was passing the kennels at about one o'clock on Thursday. At this point a right angle is passed and a few of the oxen do not come into the view, but both oxen and drivers were in sight of dinner, and the remaining distance to Wautagh, was made without accident.

## The Design of Transformers and Choking Coils.*

BY JAMES WHITCHER.

If any apology is needed for touching upon this familiar theme, I put one forward in the belief that there is still much of mystery in it for some practical men, as well as for many of the new hands that are crowding with hasty enthusiasm into the trade, so that, if perchance the subject demands their attention, and, as more often, with a call quickened with all the disconcerting urgency that commercial exigencies can devise, they are found wanting, or else must make a hasty painful gleaning along the thorny paths of empiries.

Generally the mathematical design of transformers and choking coils runs on common lines up to a certain point; and the fundamental formulæ of the one apply equally to the other, though there are usually very different conditions. To establish our first mathematical conceptions of a transformer we should regard it simply as a choking coil designed theoretically to choke off all current. Thus, if in simile we describe a choking coil as a magnetic sluice gate, a transformer would correspond to the condition of a sluice gate shut right down. The primary coil alone comes into these preliminary considerations, the secondary being only concerned therein in respect of the space it will occupy. And we would here remark it is well to dismiss once for all one's vague notions of mutual induction; the term is a mere catch phrase, a snare for the unwary. The truly logical method of treating the subject is to keep the two steps quite distinct—the production of an alternating magnetic field by the primary current, and the consequent production of an alternating electric motor force of opposite phase in both the primary and secondary coils. The reaction of a secondary current upon the field, and through the field upon the primary current, maintaining equivalence of the ampère turns of each coil, can then be more readily seen and appreciated than if it is attempted to arrive at it by reasoning around mutual inductions without reference to the field.

The following symbols will be used:

E = the maximum E. M. F. of electrical source or supply. The alternations will be assumed to be true harmonic variations; and therefore E will equal the nominal or virtual E. M. F. of supply in C. G. S. units multiplied by $\sqrt{2}$ or — $E = 10^8 \times \sqrt{2} \times$ nominal volts.

e = any instantaneous value of the E. M. F. of supply; being a harmonic or sine variable, $e = E \sin. pt$.

B = maximum induction in C. G. S. lines per square centimetre.

b = any instantaneous value of the induction; it is also a sine variable, and $b = B \sin. (pt - 90)$.

n = frequency, or number of complete alternations per second.

I = maximum current in primary, supposing secondary absent or on open circuit; usually called exciting current, being that current which produces the alternating magnetic field—in C. G. S. units. 10 amps. = 1 C. G. S. unit.

i = any instantaneous values of the exciting current; it is a complete variable, and, paradoxical as it may seem, is a function of b, the induction it generates.

S = the number of primary turns. The word "turn" may mislead, as I have known it to do; it may be better defined as the number of times the conductor repeats itself upon the field, which includes the case of a straight conductor in relation to its adjacent field without regard to the remainder of the electric circuit.

A = the sectional area of the magnetic circuit in square centimetres.

l = the mean length of the magnetic circuit in centimetres.

$\mu$ = the permeability of the iron; it is an irregular dependent variable of b.

$p = 2\pi n$; a multiplier for converting linear measure of time into cyclic measure.

t = time in seconds measured from any moment e is passing through its nil value from negative to positive sign.

Now for a transformer we have, as our first consideration, to design the primary as a choking coil which, while of very low resistance, shall permit only the smallest practicable current to pass through it when put across the supply mains; that is, one in which this small current is sufficient to generate an alternating field of such strength that its reaction on the primary coils is to produce in them an opposing E. M. F. of self-induction equal to the E M. F. of the supply. It should here be observed that in all inductive coils put on constant potential supply, the current through them will rise until the consequent E. M F. of self-induction, together with the E. M. F. lost on resistance, are equal to the E. M. F. of supply; the object in transformers is to obtain this equality within a low range of current, and on the assumption that the ohmic E M. F. is negligible.

Therefore, we must have the following relations:

Induced E. M. F. varies directly as the rate of variation of the induction: and for a coil of S turns it is expressed hus in the language of the calculus, which cannot easily be avoided:

$$e_1 = S\,A\,db/dt \qquad (1)$$

therefore must $$-e = S\,A\,db/dt \qquad (2)$$

and $$-E \sin. pt = S\,A\,db/dt \qquad (3)$$

integrating $$E \cos. pt/p = S\,A\,b \qquad (4)$$

Now, b is a sine variable because e is a sine variable, but the variation is not cophasal, as may be seen from equation (2); that is to say, e and b do not reach their maximums at the same time. For by the rules of maxima and minima b is at maximum when $db/dt = 0$; and as $db/dt = -e/AS$, b is maximum when $e = 0$. Now, $e = E \sin. pt$ is only $= 0$ when pt is 0 degree or any multiple of 180 degrees; and since $b = B \sin. x$, there must be a difference of 90 degrees between pt and x; and x must be behind pt or $= pt - 90$, since b is an effect of e. Therefore

$$E \cos pt/p = S\,A\,B \sin. (pt - 90) \qquad (5)$$

$$E = S\,A\,B\,p = 2\pi n\,S\,A\,B. \qquad (6)$$

$$A\,S = E/2\pi n\,B \qquad (7)$$

$$= 0.2251\,E_1/Bn \text{ and } = 22510000\,E_2/Bn \qquad (8)$$

where $E_1$ and $E_2$ are the virtual E. M. F. in C. G. S. units and volts, respectively.

This is a very important relation; given the voltage and frequency of the supply, and having determined on a suitable induction maximum, we have a simple numerical relation which must subsist between the cross-sectional area of uniform field and the number of primary turns, altogether irrespective of the size or capacity of the transformer.

Having worked out the numerical value for the right side of the equation, changes may be rung on the possible values for A and S, and likely ones chosen for trial.

The next process is to determine the exciting power or magnetomotive force necessary to produce the magnetic flux of maximum intensity B. In working this out we may find the number of turns fixed upon in the first place insufficient or otherwise unsuitable, and other values must be tried. Here the output of the apparatus comes in question. The size of wire for the coil is determined by the current to be carried at full load. Account must be taken of the drop of volts through the coil due to $C^2R$ loss; as the total length of wire is at first indefinite, the full load density may be put at, say, 750 per square inch, and altered subsequently if desirable. The cross-sectional area of coil space can now be determined; in a transformer this should be doubled to provide for the secondary coil, which will have approximately the same area, having to convey an equal energy, and an allowance made for any outer taping or extra insulation.

Then, for a transformer or coil of the closed iron circuit type, the mean length of the magnetic circuit may be found from a diagram of the contour of the core in the usual way, by measuring along the centre lines of symmetry—a method near enough for practical purposes, but not entirely correct, as the induction is not in any form spread uniformly over the area as it assumes. An allowance must be made for joints; for lapping joints an addition of 10 to 30 centimetres to the length may be sufficient; butt joints are not advisable.

Magnetic flux is directly proportional to the magnetomotive force, divided by the sum of magnetic resistances; that is,

$$N = A\,b = M/R. \qquad (9)$$

Magnetic resistance varies directly as the length, and inversely as the area and permeability of the magnetic circuit. For a continuous circuit of iron, therefore,

$$R = l/A\mu \text{ and } A\,b = A\,M\mu/l \text{ or } b = M\mu/l \qquad (10)$$

$$M = 4\pi S\,i \text{ and } b = 4\pi S\,i\mu/l \qquad (11)$$

taking maximums $$B = 4\pi S\,I\mu/l \qquad (12)$$

and $$I = B\,l/4\pi S\mu \qquad (13)$$

Here we have the maximum exciting current: if it exceeds, say, 10 per cent. of the effective ampères at full load, S should be increased till I comes within that percentage. In good practice the effective ampères of exciting current as measured by dynamometers are usually made from 2 to 5 per cent. of the full load effective ampères.

All the requisite dimensions can be satisfactorily determined from these simple relations, and the best relative weights of iron and copper found for the particular design A few tentative experiments with the formulæ, substituting various values for the principal factors, will exhibit the influence these factors have over the result more clearly than much explanation.

The design of the secondary coil of transformer is a very simple matter. The required ratio of transformation gives the ratio of primary and secondary turns, unless there is appreciable magnetic leakage; with modern closed circuit transformers working at the low inductions usual, there is none to speak of. The respective sections of conductors should be to one another as the inverse of the same ratio; though sometimes the disposition of the two coils may cause the lengths and weights of wire in each coil to be disproportionate; so much so that in regard to the drop or ohmic loss it may be advisable to alter the relative sections. Generally the sum of the $C^2R$ losses in both coils at full load should not exceed 2 per cent. of full load in watts, and commercial considerations show that it is folly to reduce it below 1 per cent.

The design of choking coils with closed magnetic circuits is practically identical with the preceding. Usually the conditions are that the coil shall generate in itself an opposing E. M. F. of given magnitude with the passage of a certain current. For instance, for working arc lamps on an alternating 100 volt circuit a coil is required to present a counter E. M. F. of about 50 volts with the lamp current of, say, 10 ampères flowing through it. The maximum value of these factors may be inserted for E and in our formulæ, a value chosen for B and its dependent; variable $\mu$, and convenient dimensions found for A S and l. There is some uncertainty as to the maximum of the current, due to the irregular character of its curve, but practical calculations are usually sufficiently near if made on the assumption that the maximum is, say, 1.5 of the effective ampères.

It will probably be found that the amount of iron required is excessive; for, the available magnetomotive force being large, b will need to be large or S very small, in which latter case A becomes unwieldy. Making the induction larger causes waste and heating and noise, which should be avoided. But the iron may be reduced by any amount by the use of an air gap in the magnetic circuit. A very narrow gap has a marked effect; and it is extremely useful for making the final regulation by a slight opening or closing of it.

The effect of the gap is exhibited in our formulæ, thus —

$$N = A\,b = M/R = \frac{M}{\frac{l}{A\mu} + \frac{l_1}{A_1}}, \qquad (14)$$

where $l_1$ and $A_1$ represent the length and area of the gap. This method only applies when $l_1$ is small. Presuming there is no polar enlargement, $A_1$ may be taken as equal to A + a surrounding fringe of width equal to the length of gap as usual in dynamo design, or less accurately as equal to A. Then

$$b = \frac{M}{\frac{l}{\mu} + l_1} = 4\pi S\,i\left(\frac{\mu}{l + \mu l_1}\right). \qquad (15)$$

Comparing this equation with that for closed circuits,

$$b = 4\pi S\,i\mu/l, \qquad (11)$$

and remembering that the value of $\mu$ is numerically large compared with that of l, the great influence of an air gap can be seen. Here is a strong argument against the use of butt joints in transformers unless fitted in a perfect and therefore costly manner.

Choking coils, as well as being almost wasteless substitutes for resistances, have a further utility over dead resistance. Thus a resistance offers only what may be described as a linear regulation; that is to say, if the E. M. F. on it is altered in any ratio—for instance, doubled—the current through it is doubled too. But choking coils offer greater flexibility of design in this particular. If the working induction is chosen so that $\mu$ is near its summit value, the regulation in one direction will approximate to that of a resistance; but by putting the induction at such a point that the permeability is on the rising slope of its curve, regulation of a sharper kind may be secured. In other words, the current is restricted to a shorter range than the volts; and if an induction be taken with the permeability on the downward slope, this condition is reversed.

This property may prove of use in connection with apparatus that are liable to make sudden and disturbing demands for current on a constant potential supply; for example, large arc lamps. Supposing it a 50 ampère lamp on 100 volt circuit; with resistance the current at starting will range up to about 100 ampères, and if at lower voltage the limit will be proportionately greater. With a coil de-

* From the London *Electrician*.

signed with induction of 5,000 the range of current under some conditions may be kept under 65 ampères, about. This can only be obtained with coils having complete magnetic circuit of iron: the presence of an air gap masks the effect.

If an even more emphatic effect of this kind is required it might be obtained by making a coil with an air gap which opens and closes automatically with fall and rise of current. The magnetic condition of the core will generally yield a sufficient tractive force to do this against an opening spring the force of which can be readily regulated.

Thus much for the simple mathematical design of these important appliances. There is much to be said of the mechanical design of the same, also of the design of transformers for particular load factors or conditions of working, and of the whole question of the pre-estimation of losses; but it must be left for other occasions. Open circuit coils and transformers and alternating current solenoids are much more difficult of treatment than the simpler cases taken, yet they have some very important practical bearings.

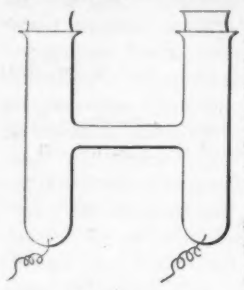


FIG. 1.

The above must not be regarded as more than a plain statement of first principles put in practical form with as little mathematics as possible. More refined methods of designing transformers there are involving less tentative work, but they require more mathematical gymnastics than some may like to venture on at first.

## The Standardizing of Electrical Instruments.—I.

BY W. M. HILL.

### INTRODUCTION.

As the application of electricity as a power for moving machinery becomes more general, more and more attention is paid to the finding of causes for the waste of power, so that greater efficiency and economy may be obtained in the use of the same. This necessitates the very accurate measurement of electrical quantities, for which new and improved forms of instruments are constantly being invented. This article is intended to give the newest methods for the standardizing and checking of these delicate instruments, in the course of which practical applications of certain well known methods for measuring low resistances and comparing E. M. Fs., as applied to this purpose, are described.

### CLARK'S CELL AS A STANDARD.

For the standardizing of instruments which measure the E. M. F. in volts and the current in amperes, Latimer Clark's cell, used first as a standard for E. M. F., and afterward for current, has been found to be the most convenient and practical. The E. M. F. of this cell remained extremely constant for the same temperature during a long series of experiments at the Weston laboratory, when only a very small current was allowed to be taken from it.

Although these cells are set up in a variety of forms, the H form, which consists of two tubes joined by a third halfway down their length, is considered the best. This form is shown in Fig. 1.

One of these tubes is filled to about one-fourth of its length with an amalgam of zinc, formed by distilling mercury, in a vacuum, until it is absolutely pure, and putting into it some pure zinc, and the other, to the same height, with pure mercury, also distilled in a vacuum, and covered with a layer of mercurous sulphate, the surface coming below the connecting tube. Both tubes are now filled to a height above the connecting tube with a pure saturated solution of zinc sulphate, with a few crystals of the same added. The tops of the

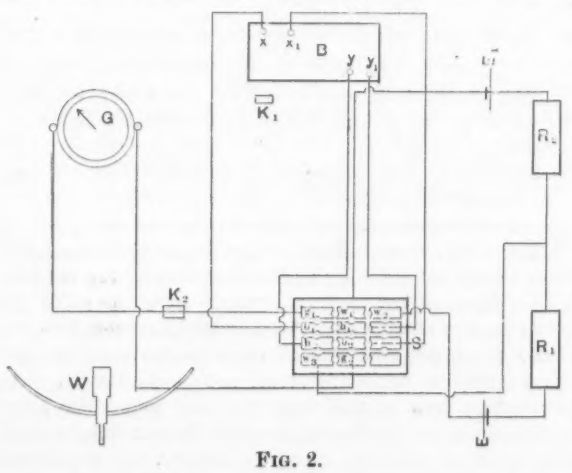



FIG. 2.

tubes are stopped by paraffined corks, cemented in, so as to completely stop evaporation. Through the bottom of each a platinum wire is placed, making connection with the amalgam on one side and the mercury on the other. When these cells have been used several times, or have stood for some weeks, it is necessary, before again using, to check them off with each other, and with a Daniel, or some other cell of constant E. M. F. A practical method for doing this is Bosscha's method, shown in Fig. 2.

*Apparatus.*—A Wheatstone bridge B. $x_1$ x being the galvanometer connections, and y $y_1$ the connections for the unknown resistance; a delicate high resistance galvanometer, G, fitted with a scale and telescope W; two contact keys, $k_1$ and $k_2$, for the bridge and the galvanometer; two resistance boxes $R_1$ and $R_2$ of about 20,000 ohms each; a switchboard, S, consisting of a number of metallic plates with a binding post on each for wire connections, capable of being connected with each other by plugs.

*Method.*—Connections are made as shown in the figure, E and $E_1$ being the cells to be checked. The following plates of the switchboard are connected by plugging; $w_1$ with $r_1$, $w_2$ with $r_2$, $g_1$ with $b_1$, and $g_2$ with $b_2$. Nearly 20,000 ohms are measured off, adjustment being made by altering $R_2$, $k_2$ being closed. The plugs are taken out, and the following plates connected: $w_2$ with $r_1$, $w_3$ with $r_2$, $g_1$ with $b_1$, and $g_2$ with $b_2$. The same resistance as before is measured off by adjusting $R_1$. The plugs are taken out, and $g_1$, $w_1$ and $w_2$ are connected, as well as $w_3$ and $g_2$, $k_2$ being open; $k_2$ is closed, and, if there be no deflection on the galvanometer, the E. M. Fs. of the two cells are equal. Other cells may be substituted and tried in the same manner.

As a galvanometer may be obtained by which one Clark cell gives one degree deflection for 59,316,240 ohms in series, this test is accurate enough for practical purposes. To compare a Clark cell with another cell of constant E. M. F., Poggendorff's compensation method may be used. This method is shown in Fig. 3.

*Apparatus.*—The same as in Fig. 2, except a high resistance, D, of about 200,000 ohms, to prevent strong currents from passing through the cell by accident, a battery of constant current C, and a cell T, of constant E. M. F.

*Method.*—Connect $g_1$ with $w_1$, and $g_2$ with $w_3$. Adjust $R_1$ and $R_2$ until there is no deflection on the galvanometer, always keeping the resistance between l and m constant and equal to about 10,000 ohms. Disconnect and find the resistance between o and m very accurately upon the bridge; let this be n. Substitute the Clark cell in place of T, and connect as before. Repeat the test, and obtain a new resistance, n. Then

$$\frac{T}{E} = \frac{n}{n_1}.$$

In these tests the readings of the resistance boxes

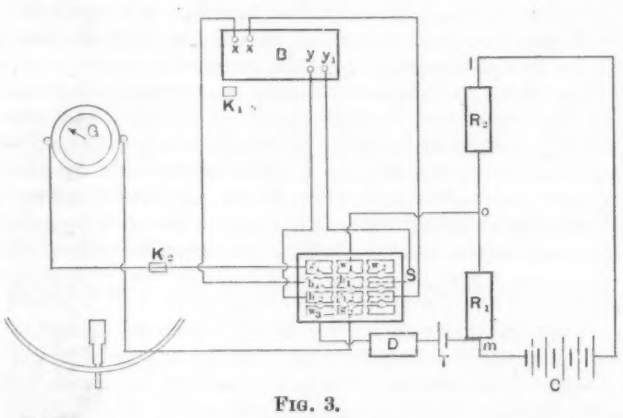



FIG. 3.

may be taken, thus rendering the Wheatstone bridge unnecessary, and neglecting the small resistances of the connections; but, as these boxes are seldom reliable, and a bridge may be obtained which is guaranteed as correct to one fiftieth of one per cent., it is better to measure the resistances as above.

### STANDARDIZING A VOLTMETER BY CLARK CELLS.

For a standard voltmeter it is best to use one of the Weston laboratory standard instruments; first, because the scale of these instruments is very uniform throughout; second, there is no appreciable magnetic lag, temperature error, or friction; third, the magnet does not change for a long period; and, fourth, it is a very sensitive and accurate instrument, having a very long pointer and scale. This voltmeter consists of a strong permanent magnet of the form shown as A in Fig. 4. Between the poles of this magnet is fixed a soft cylindrical iron core D; revolving between this core and a pair of soft iron pole pieces, c c, fitted against the poles of the magnet, is a small coil of fine wire (H) wound upon an aluminium frame, which is supported vertically upon jeweled pivots.

Fastened rigidly to this frame is a long aluminium pointer P, which is carefully balanced by a framework g, fitted with small screws for adjustment. This pointer is held in position on zero by two delicate spiral springs, one above and one below the aluminium frame, the current passing through these springs. A high resistance coil of German silver is in series with the movable coil. For the standardizing of this instrument a set of Clark cells is required. These cells may be obtained in a set of seven, filled up in a box, with convenient binding posts. The E. M. F. of a Clark cell being 1,438 (1 — .00077 [t — 15°]), where t is the temperature of the cell in degrees centigrade, seven would give an E. M. F. of 10.066 volts at 15° C., and this is a convenient number.

To calibrate the instrument, the German silver series wire is adjusted until the pointer comes to the right spot on the top of the scale for about the desired number of volts. This may be determined by checking the standard in parallel with any voltmeter somewhere nearly correct. Connection is made with the Clark cells as shown in Fig. 5.

*Apparatus.*—The same as in Fig. 3, except a set of storage batteries, or any constant current generator;

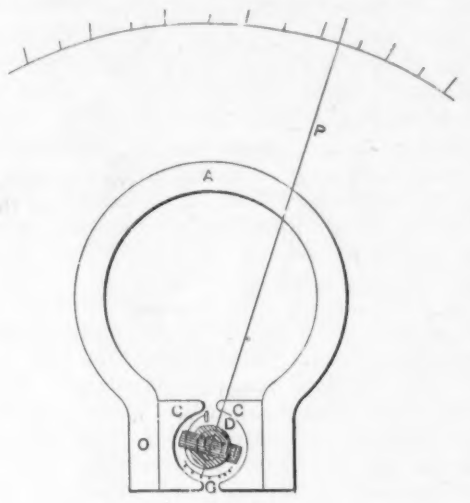



FIG. 4.

a rheostat H, capable of making very small changes of resistance; a Weston laboratory standard voltmeter M; a set of Clark cells E; a high resistance of about 200,000 ohms D, in series with the Clark cells; a piece for connecting together two wires i $i_1$, of unappreciably small resistance, and having two binding posts and a contact key, $k_3$.

*Method.*—Connect up, as shown in the figure, except that the ends, i $i_1$, go to the posts y $y_1$, and the ends, j $j_1$, go to the same post j. Carefully measure the resistance i $i_1$ j p o Q upon the bridge; and let this be $E_2$, connecting plates $g_1$ with $w_1$, and $g_2$ with $w_3$. Calculate the E. M. F. of the set of Clark cells by the formula 1.438 (1 — .00077 [t — 15°]), and let this be $E_1$. Let the required E. M. F. be $E_2$ and $e_1$ be the resistance of o Q, when a balance is obtained. Find the value of $e_1$ from the formula

$$\frac{E_2}{E_1} = \frac{e_2}{e_1}.$$

Adjust the resistance between o and Q very carefully upon the bridge, until it is equal to $e_1$ by altering $R_1$. Connect up as before, leaving ends i $i_1$ in y $y_1$ and j $j_1$ in the same post j, and adjust the resistance of i $i_1$ j p o Q until it is equal to $e_2$, by altering $R_2$, thus keeping this resistance constant.

Disconnect i $i_1$ and j, and remove all plugs from S; now connect as shown in the figure, the plates $w_1$ being connected with $g_1$ and $w_3$ with $g_2$; move the arm of the rheostat H until the pointer of M comes to about the right spot on the scale; open and shut $K_2$, and, if there be a deflection on G, move the arm as before, until a point is reached upon the scale where there is no deflection; make a mark at this point.

Alter the resistances in $R_1$ and $R_2$, and keeping the pointer upon the mark, adjust again until there is no deflection upon G; always keeping the resistance of $R_1$ + $R_2$ constant; measure $e_1$ and $e_2$; and, if there has been any change in the temperature of the cells, again calculate $E_1$; find $E_2$ from the formula; and, if this differ from the first value, move the pointer by the right percentage on the scale and make a new mark; check this

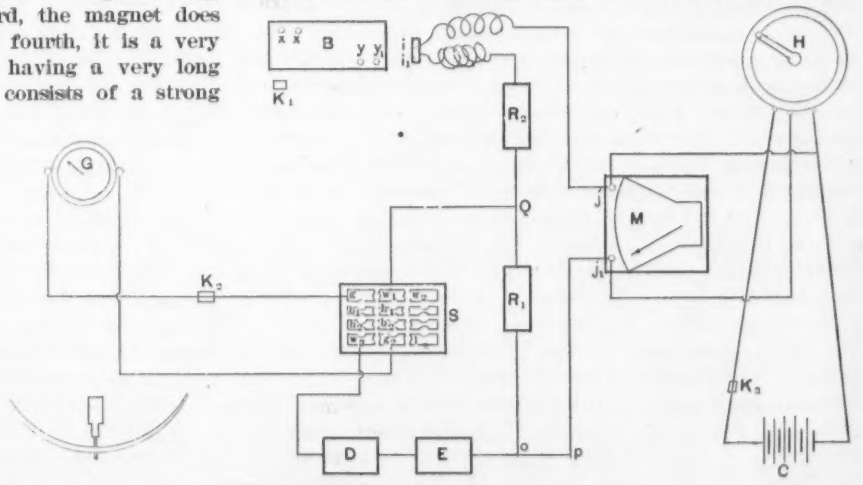



FIG. 5.

mark as before, and continue, until a mark is obtained which checks exactly by this test.

In this manner marks are obtained at equal distances down the scale, and the spaces again sub-divided by draughting instruments, for the scale is quite uniform. In drawing marks upon the scale care should be taken that no charge be upon the pointer, scale, or other parts of the instrument, as a charge of this character considerably alters the readings. A slight friction upon any non-conducting part may produce such a charge, so the instrument should be frequently gone over with the hands, and the non-conducting parts breathed upon.

# THE ELECTRICAL WORLD'S DIGEST

OF

# CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

## ELECTRO-PHYSICS.

*Electric Spark Photographs.*—A recent issue of "Nature" gives a full report of a lecture by Mr. Bois on this subject, a short editorial notice of which is contained in the Lond. "Elec. Rev.," March 24. Numerous interesting points are brought out, but the paper belongs more particularly under the head of physics rather than electricity. In photographing the passage of a bullet, the bullet itself closes a subsidiary electrostatic circuit consisting of a small condenser and a spark gap; this spark, in turn, completes a second similar circuit having a large condenser and a spark gap; the spark from the second circuit produces the light for the photographic plate, the bullet at that moment being between the light and the plate. The auxiliary condenser is charged from the larger by a wet string which acts as a conductor, but during the discharge it behaves as a perfect insulator; by this device he concentrates the whole discharge of the larger condenser at its spark gap. When the bullet is traveling at a greater rate than the velocity of sound, there is shown on the photographic plate a rippling of the air before and behind the bullet; it is suggested to use this to measure the velocity of sound. The fact that these ripples are photographed on the plate is due to the different refractions of the light in the more or less dense air. The same apparatus may be used to show the order of sequence of two sparks which succeed each other in very rapid succession.

*Novel Electroscope.*—Mr. Rimington in the Lond. "Electrician," gives an addition to his paper on experiments in electric and magnetic fields, published in "The Elec. World," Jan. 28, p. 63. In that paper he describes an experiment showing the illumination of an electrodeless vacuum tube which was rotated in a constant electric field. He now finds that these experiments can be shown much more simply by bringing a rubbed ebonite or glass rod near to the rotating tube; the illumination will then be nearly as brilliant, but the fan-shaped images will not be quite as symmetrical unless the tube be fastened to the end of a long insulated rod. An ebonite rod excited by being drawn through a piece of dry flannel will produce one image when held at a distance of over one foot from the tube; it thus forms a novel electroscope. The best form of tube is a straight glass tube of about 5 inches in length and having a bore about like a spirit thermometer, with a bulb blown at each end, and a T piece at the middle which serves as the axis around which the tube is revolved. The revolving of the tube need not be done by means of a motor, as a simple turning between the fingers is sufficient. The experiment is an interesting one, as the infinitesimally small extra power required to revolve the tube when it is in the electrical field is practically converted directly into light.

## UNITS, MEASUREMENTS AND INSTRUMENTS.

*Congress Proposals.*—"L'Elect.," March 18, gives a full translation of the American proposals for the coming congress (see The Electrical World, Jan. 21, p. 50, together with some criticisms by Mr. Meylan, one of the editors, the substance of which is as follows: He objects to the term "magnetic intensity," which he says is not used in France or Germany, where the term "magnetic induction" or simply "induction" is employed for the same quantity. Regarding the suggestion to distinguish the concrete standards from the true units by calling the latter "true amperes," "true ohms," etc., he suggests to use the word "legal" in connection with the concrete standards. Regarding the definition of the impressed electromotive force, he questions whether this definition applies to a well-determined physical quantity, and even if so he does not see the use of this new term. Regarding the definition of "inductivity" he prefers the term "permeability" defined as the ratio of the induction to the magnetic force. He suggests introducing terms for dielectric properties for which Mr. Heaviside introduced the terms "permittance" and "permissivity." He questions the correctness of the definition of the mutual inductance saying that in two systems, A and B, the magnetic flux which traverses B when unit current flows through A is equal to the flux which traverses A when the same current passes through B. He questions the correctness of the simple definition for "reluctivity;" reluctance is analogous to resistance in an electric circuit and reluctivity bears the same relation to reluctance as the specific resistance (which one ought then to call resistivity) bears to the resistance; specific resistance is not a differential of the ratio of the resistance and the volume; the dimensions of reluctance are those of $\mu L$, while those of reluctivity are those of $\mu$; if reluctivity was $\frac{d\ \text{reluctance}}{d\ V}$ its dimensions would be $\frac{\mu\ L}{L^3} = \mu\ L^{-}$ and the above definition is then incorrect. Regarding the definition of diphase currents he said that phases can differ among themselves only by a fraction of a phase and not by 270° as stated. Regarding the suggested universal use of a number of terms, he states that this is not the province of an International Congress, as every language has its own terms which are determined by usage and good writers. In reviewing the adoptions of previous congresses, he criticises the mathematical expression adopted by the Paris Congress of 1889, to designate the mean intensity of an alternating current; he says that this expression is absurd, as the intensity when thus defined is always zero; it is a half period which ought to be referred to.

The discussion of Mr. Blondel, at the Societe Int. des Electriciens, is contained in part in "La Lum. Elec.," March 18. He objects to the definition of "inductivity" and prefers the term "permeability," which he says is now in universal use and is simply the ratio of the magnetic induction to the magnetizing force at that point; this, he says, is shorter and much clearer. He objects to the definition of the impressed electromotive force, which, he says, is not exact for alternating currents on account of the difference between the phase of the current and that of the difference of potential producing it. He states that the impressed E. M. F. is equal to the effective E. M. F., plus the E. M. F. of self-induction. He objects to the way in which the Americans and the English use the term electromotive force, as they frequently use it synonymous with difference of potential (in this, however, he is not correct, as careful writers in this country make the same distinction as is made in Germany and France); he protests against the use of the term "voltage." He prefers to use the term "inductance" as representing the inductive resistance which a circuit possesses when traversed by an alternating current; the effective intensity can, without making any hypothesis, be represented as follows:

$$C = \frac{E}{\sqrt{R^2 + K^2}}$$

K being called the inductance; in this way one will never be led to make an error; in Ohm's law K would be equal to $\frac{2\pi}{T}L$. He states that the definition of the coefficient of self-induction leads to serious misunderstandings, for the following reason: Suppose two coils without iron are connected first in series, having a current C, and second in parallel, having a current 2C, then in both cases the total flux is the same, and consequently, according to the proposed definition, the self-induction will in the second case be half of that in the first, while in reality it ought to be reduced to one-quarter. The definition is furthermore not applicable to the case of magnetic circuits containing iron; he proposes to define it as follows: The coefficient of self-induction is at every instant the ratio of the counter E. M. F. produced by the variation of the current, and the quotient $\frac{dc}{dt}$ in which c is the current and t the time. He objects to the definition of "reluctivity," which, he says, is inexact because the magnetic resistance is not a function of the volume alone, but depends, as is well known, on $1 \div s$. He furthermore asks why this term should have a special name, as it is simply the reciprocal of permeability (That is no reason why it should not have a name); he suggests giving the name "lux" to the unit bougie metre. Regarding the proposed concrete standard of light, he suggests allowing one to have the liberty to adopt any secondary standard. In France, for instance, he states that the carcel is quite satisfactory; he calls attention to the fact that the nature (color) of the light of the Hefner-Alteneck lamp is different from that of the arc light, and is, therefore, not suited for measuring such white lights.

The remarks of Mr. Guillaume in this discussion will be found in full in another part of the present issue.

The Bulletin of the "Societe Int. des Electriciens," for February, contains an abstract of the American proposals with a few comments. It approves of the suggestion not to change the value of the units already in universal use; it objects to defining the ampere by the weight of silver deposited instead of by the mass; the former is different at various distances from the earth's equator, the extreme difference being about 0.5 per cent; this error in the definition, it claims, ought to be corrected. Regarding the new ohm it states that there is no objection to adopting it, but when adopted it ought not to be again changed at a subsequent congress. Regarding the system of notation, it says that it would be as difficult to get the French to use C for a current as for the English to use I. Regarding the definition of impressed E. M. F. it suggests that it would be clearer to say that at any given instant it is the quotient of the true power and the instantaneous value of the current at the same instant. It states that adopting expressions for describing electromagnetic wave phenonema is hardly within the province of the congress. It does not approve of the term "voltage," saying that it was evidently not intended to be used for expressing a difference of potential in electrostatic units also.

*Terms.*—Mr. Claude, in "L'Ind. Elec.," calls attention to the incorrect use of terms in expressing the insulation and capacity of cables; the capacity being proportional to the length, a kilometric capacity ought to be expressed in microfarads per kilometre, but the insulation resistance, on the contrary, is inversely proportional to the length and a kilometric insulation ought therefore to be expressed in megohms-kilometre and obtained by multiplying the insulation of the cable by its length. The expression megohms per kilometre, which, he says, means nothing, ought to be rejected. Mr. Hospitalier agrees with him, but states that it should be carried still farther; the terms kilometric capacity and kilometric insulation, which introduce a unit in the definition of a physical quantity, are not logical. He says that two words ought to be found to designate the quantities $C \div 1$ and $R \times 1$, and asks for suggestions.

*Tests of the Thomson Wattmeter.*—Messrs Baillie, Baylay & Woodhouse in the Lond. "Elec. Eng.," March 24, give the results for a long series of tests made at a London Institution. (They claim that this meter was patented by Profs. Ayrton and Perry, in 1882.) The Thomson meter which was tested was intended for 100 volts and a maximum of 25 amperes. Direct current tests: It was found to start with a current of 0.1 ampere; it was found to read accurately when run either with one 8 c. p. lamp or with 14 amperes; with 25 amperes the readings had to be multiplied by 1.005; the correctness of the readings were not affected by an eight per cent. variation of the voltage. Alternate current tests: If the external circuit was non-inductive the readings were correct, but if the circuit was very inductive it was found necessary to multiply the reading by a constant depending on the frequency. If accurate with direct currents it will read within 0.5 per cent. at 100 periods per second, provided the time constant of the external circuit does not exceed .00028 secohm, which is higher than that of a load of lamps. They then show how nearly the constant could be predicted from the following formula of Prof. Ayrton for the correction of a wattmeter.

$$\frac{\text{apparent watts}}{\text{true watts}} = \frac{1 + \tan\theta \tan\varphi}{1 + \tan^2\varphi}$$

in which $\theta$ is the angle of lag between the current and the voltage, and $\varphi$ the angle of lag in the armature circuit of the meter. From the measured resistance r of the armature circuit, 960 ohms, and its self-induction, 0.055 secohm, the value of $\varphi$ is calculated from the formula

$$\varphi = \tan^{-1}\frac{L\,p}{r}$$

in which $p = 2\pi \times$ frequency. The angle $\theta$ is calculated from the formula

$$\text{true watts} = \text{volts} \times \text{amperes} \times \cos\theta$$

The calculated and the experimental constants agreed very closely. They then showed how this meter may be modified so as to be used as a central station meter on high pressure mains in which the error due to the relative time constants of the meter and the external circuit would disappear, and as it does not have to start with such a small current, the number of turns of the armature might be reduced.

*Measuring the Specific Inductive Capacity.*—Mr Heerwagen, in the "Wied. Ann." (abstracted in the Lond. "Electrician," March 17), describes what appears to be a simple null-method for measuring the specific inductive capacity of conducting liquids. The instrument is a differential electrometer constructed of two needles fixed to a common axis and hanging in quadrant pairs over one another. The needles, case and one pair of quadrants in each instrument, are connected together and to a certain point A of an alternating current circuit, while the remaining pair of quadrants in each instrument are connected to two other points B and C of the same circuit; the latter points are so chosen that there is no deflection of the needles. The instrument is first adjusted with air as the dielectric and then with the lower electrometer filled with the liquid to be measured. Let r and r′ be the resistance from A to B and A to C respectively, in the first case, and R and R′ be those in the second case, then the specific inductive capacity of the liquid is equal to

$$\left(\frac{R}{R'} - \frac{r'}{r}\right)^2$$

The upper electrometer should be more sensitive than the lower. The resistance of the suspension prevents the needles from being at exactly the same potential as the case, a fact which is of importance; an equivalent resistance should be provided between A and the case and quadrant. The specific inductive capacity of pure water was found to be 79.56 at 20.75 degrees C.

## DYNAMOS, MOTORS AND TRANSFORMERS.

*Alternating Current Motor.*—Mr. Kingdon, in the Lond. "Electrician," suggests a "hysteresis theory" for explaining the action of the non-synchronous motor recently described by Mr. Brown (see The Electrical World, Feb. 25, p. 138). He states that it is often supposed that the secondary currents in a transformer are in quadrature with the primary, that is, that they are zero when the primary currents are a maximum, and vice versa; this, he says, is not correct, but that, on the contrary, the secondary currents are nearly co-phasal with the primary, but opposite in direction; that is, the primary and secondary currents have maximum values at almost identical moments. He states that the truth of this has been proved experimentally. If the secondary currents were in quadrature to the primary, the magnetic induction of the core would increase very considerably and the pressures would rise, but as a matter of fact the constancy of pressure shows that the magnetizing effect of the secondary current is equal and opposite to the magnetizing effect of the primary current, not considering, however, the initial magnetizing current.

An important point in the Brown motors is that the air gap is absolutely uniform and does not contain a pair of rotating poles as in the Tesla-Ferraris motor. The momentary north and south poles produced by the primary currents are opposed by similar poles produced by the secondary current which tend to counteract the poles of the primary current. If by some device the motor is started the effect of hysteresis comes into play and different conditions result, the effect being that the hysteresis of the iron distorts the magnetic field. The final result is that the magnetic polarity produced by the secondary current is distorted through an angle and the poles produces by the primary and secondary circuits are therefore no longer in the same place, thus producing a torque, as they will then be repelled in a certain definite direction; when the motor is at rest the repulsion is, so to speak, in both directions at once like in a body in unstable equilibrium, and therefore it produces no torque; but even if the rotating part is in motion the secondary poles would remain opposite to the primary poles were it not for the effect of hysteresis in distorting the resultant field. There is not much actual distortion until both currents decrease almost to zero, which they do nearly simultaneously. In conclusion, he says that if this explanation is correct, hysteresis, which heretofore has been a vexatious phenomenon, may turn out to be a property of great value.

ARC AND INCANDESCENT LIGHTS.

*Forcing Incandescent Lamps.*—Mr. Stearn. in commenting on the article by Dr. Boehm, published in The Electrical World, Feb. 4, p. 82, writes to the Lond. "Elec. Rev." stating that from experiments he finds that it is not at all difficult to construct lamps which do not blacken materially during 300 hours; the results of some trials of these lamps were given by Mr. Haubtmann in "L'Electricien," Sept. 24, 1892. These trials show that lamps of 12 candles during 300 hours change from 12.9 to 11.7 c. p., and the efficiency from 2.65 to 2.69 watts per candle. The 16 c. p. lamps change from 17.62 to 16.65 candles and from 2.73 to 2.75 watts per candle in 250 hours; the average life of 12 c. p. lamps was 300 hours and of the 16 c. p. 600 hours Mr. Stearn believes, however, that a much longer life n be obtained with efficiencies from 2.5 to 2.7 watts. From tests he thinks that 500 hours can safely be relied upon with a loss of not more than 20 per cent. in the candle power; he believes that there is reason to hope that it will not exceed 12 per cent. in 500 hours; many of the trials show no diminution during 100 hours; in one case the efficiency changed from 2.5 to only 2.6 in 300 hours.

*Diffused Light.*—The Lond. "Electrician" reprints an article from a Viennese gas journal, on indirect lighting, which gives some interesting results regarding diffused light. With ordinary lighting, six seats on one bench in a lecture room in the university had an illumination of 8.4, 12.7, 45.8, 74.9, 16.9 and 11.0 metre-candles, respectively (one metre-candle is about equal to a foot-candle). Various mirrors and reflectors were then introduced below and above the lights, so that the illumination consisted entirely of diffused light. There was then no shadow and no reflection from the walls, the flames were out of sight and the objectionable heat from the lights did not radiate downward; the room seemed to be divided into two zones, the upper one bright and the lower one dark; the only defect was the comparative darkness of the lower part of the room. Measurement showed that with the same consumption of gas the illumination in the brightest place was 26.15 metre-candles with direct and 8.59 with indirect lighting, and that in the darkest place was 16.58 and 6.74, respectively; the average was 21.33 and 7.64, showing a loss of 64.2 per cent. The illumination was not sufficient in the second case, as it was found that nothing less than 10 metre-candles (or about one foot-candle) was sufficient. The walls of the room were then painted a pure white; the averages then were 24.01 and 9.11, or a loss of 62.5 per cent. A semi-transparent reflector of paper was then substituted; the averages were then 21.01 and 9.94, or a loss of 52.7 per cent.; paper, however, is not a good material, as it discolors. Milk-glass was then tried, as it was, to some extent, both transparent and a good reflector; the room then looked much brighter; the averages then were 27.05 and 17.48, showing a great increase; the loss was thereby reduced to 35.6 per cent., and the worst lit part of the room was found to be sufficiently illuminated; the lighting, however, was not so uniform with a semi-transparent reflector and the shadows were not entirely absent.

*Arc Lighting from Balloons.*—The Lond. "Elec. Rev." states that experiments have recently been made by the German military authorities to illuminate from captive balloons, the source of the current being upon the ground. The light was 5,000 candles and at a height of 600 metres an area of about 500 metres in diameter was well lighted; from a height of 150 metres over half a mile of road was illuminated. The experiments were very satisfactory, the method is said to be particularly useful in siege operations, for which purpose they are to be used.

TRANSMISSION OF POWER.

*Portable Electric Planer.*—The English journals of March 24 give a short illustrated description of an apparatus for planing the decks of ships, which is at present used by some shipbuilders in England. It consists of an electric motor placed on rollers and operating a rotary cutter on the lower surface; in some respects it resembles a lawn mower and is as easily handled as those machines. The cutter has a speed of 3,000 revolutions and the motor 2,000; the hind roller which follows the cut is fitted with electric journals which can be turned so as to adjust the depth of cut to a nicety; the current is applied by means of a double flexible lead from the stationary generator.

ELECTRIC RAILWAYS.

*The Salève Mountain Electric Railway.*—The Lond. "Elec. Eng.," March 24, gives a short description, including considerable data, of this rack and pinion mountain road. The generating station consists of three turbines of 250 h. p. each; their speed is only 45 revolutions and the horizontal dynamos are coupled directly on the turbine shaft; as this speed is exceedingly low, dynamos of a normal out-put of 1,000 h. p. are used in order to give the required power at this low speed; they are among the largest continuous current dynamos yet constructed, being 10 feet in diameter and weighing 19 tons. The generating station is about one and one-quarter miles from the central railway station; the conductors are carried overhead on telegraph poles and include two pressure regulating return wires; the conductor consists of a rail between the tracks resting on porcelain insulators; the current is taken off by means of a sliding shoe; the other rails are used as a return circuit; the loss in the lines is 15 per cent.; the cars carry 40 passengers and weigh, complete, 12 tons. There are two motors operating cog-wheels which gear into the rack; either is capable of holding and starting a loaded car on a maximum grade; the motors are four-pole Thury dynamos of about 30 h. p.; the speed of the car varies from 5 to 9.5 feet per second. Each car has four friction brakes, two electric brakes and two absolute stops; the electric brakes are formed by the motors themselves, which act as dynamos during the descent, their current being dissipated in resistances placed under the cars. The sides of the observation cars are almost wholly composed of glass windows. Each car has three axles, the middle one carrying wheels without springs; each of the others has one loose wheel to facilitate turning the curves. The line is divided into three sections of about three kilometres each; about 250 h. p. are required for ordinary working; the maximum speed is six miles an hour and on 25 per cent. grades three miles an hour; the upper station is 3,800 ft. above the sea.

*Conduit Railways.*—It is likely that the City of Vienna will soon introduce many miles of electric railways like those used at Budapest, Hungary; the latter have been fully described in this journal; a shallow conduit, below one of the rails, contains the two wires from which the current is taken by an apparatus passing through a slot in the rails. It is also likely that the Budapest lines will soon be very much extended. No better proof of the success of this interesting and unique line could be desired.

*High Speed Electric Traction.*—The Lond. "Elec. Eng" reprints a lecture of Mr. Lea on the "Possibilities of High Speed Electric Traction," which is in the nature of a semi-popular review of the subject and as such is of some interest. It does not, however, admit of being abstracted. He calls attention to the well known advantages of electric traction for high speeds and also its practical limitations, but gives little or no data of importance.

INSTALLATIONS AND CENTRAL STATIONS.

*Increasing the Efficiency of Boilers.*—The apparatus of Mr. Zahikian mentioned in these columns some weeks ago, by which the fuel economy of boilers is increased 25 per cent, it is stated by the Lond. "Elec. Eng.," to consist of an arrangement for making the water take a helical or rifling movement through the water tubes, and by this means the steam-raising power is said to be greatly increased, while at the same time the life of the tube becomes longer on account of more regular distribution of the water over the heating surface. The invention is called the "Volvo" and is being introduced in London.

TELEPHONY.

*Schiseophone.*—The "Journal of the Institution" gives the following abstract from the "Comptes Rendus": "The schiseophone is a microphonic apparatus for testing metal for flaws. A sort of Crossley microphone consisting of rods of carbon is arranged on a stand; the rods form a triangle or square, and surround, but apparently do not touch, a steel rod. This rod is caused by any suitable means to keep constantly tapping on the piece of metal to be tested. The microphone is joined up in circuit with a battery, and a coil in an adjacent room. The coil is fixed at one end of a long graduated rod, and another coil is connected to a telephone and moved away along the rod till the sound in the telephone due to the induction of the fixed coil on the movable one is almost nil. Keeping the two coils in this position, the piece of metal (rail, armor plate, etc.) is then slowly moved past the instrument by an assistant, the rod still tapping on it. Any flaw in the metal is at once detected by the sound in the telephone increasing. In testing pieces of metal of varying shape and thickness a table is drawn up, from tests on a sample known to be good, of the proper distance between the coils at which the sound should nearly vanish when the tapper is on different parts of the test-piece, and deviations from these distances when testing a similar piece denote the presence of flaws. The taps should not be more rapid than two in three seconds, and the tapper is best worked pneumatically by a ball and tube, like an instantaneous shutter."

ELECTRO-CHEMISTRY.

*Copper Dye Vats.*—In dyeing fabrics in copper vats, the metal dissolved sometimes has an effect on the dyes. A very cheap and simple method of obviating this, and one which is said to be very successful, is to place a number of zinc strips in the vat, and in contact with the copper; the area of the zinc should be about 1-5 of that of the copper; as the zinc is consumed it must be replaced occasionally.

MISCELLANEOUS.

*Death by Electricity.*—Mr. d'Arsonval before a French society gave the results of some experiments. It was found that death occurred from two general causes, mechanical lesion of the vessels and nerves, and secondly, stoppage of the functions of the heart, lungs, etc. Lightning or high tension discharges produce death by the first of these, while shocks from dynamos produce death by the second. While the first causes certain death the second may produce both apparent and actual death. He states that electrocution, besides being barbarous, is not sure, as he thinks artificial respiration may bring about life again; he believes that an autopsy is necessary to produce sure death. A rabbit cannot be killed with less than 2,500 volts alternating and 20 amperes, and even then it may be revived by artificial respiration.

*Atmospheric Electricity.*—Mr. Bidwell, in a paper read before the Royal Meteorological Society, London, abstracted in the Lond. "Elec. Eng.," March 17, stated that among the possible sources of atmospheric electricity was the evaporation of water and the friction of the dust in the air against the earth's surface; both were shown experimentally. He states that the ramified or branch flash of lightning, called forked lightning, was probably one of the most harmless forms of discharge. He states that, according to Dr. Lodge, the lightning rod is of no use for an "impulsive rush" discharge, which, however, is of rare occurrence. Mr. Preece claims that this discharge does not occur in nature, but Mr. Bidwell thinks it is quite certain that it does occur. Although in most cases lightning rods will protect buildings, yet their failure to do so, he claims, does not necessarily prove that they are defective. He thinks that "ribbon flashes" are due to the moving of the camera, and that the so-called "dark flashes" were due to leaving the camera open too long, and that they were therefore not an electrical effect at all.

*Electric Furnace.*—The Moissan furnace, mentioned before in these columns, is constructed by Mr. Nion as follows: The interior is made of a closed cylindrical carbon vessel whose diameter is equal to its height, and made of tar and powdered retort carbon; it consists of a carbon tube resting on a slab and closed with another slab; inside of this cylinder is the carbon crucible; the whole is enclosed in two blocks of limestone; the carbon vessel is separated from the limestone by a 5 millimetre air space and rests on magnesia supports. For currents between 300 and 500 amperes the carbon cylinder is 6.5 centimetres in diameter, the electrodes are 3 to 3.5 centimetres in diameter. The furnace is illustrated in the Lond. "Electrician," March 24.

*Ozone.*—The serial on Ozone in the Lond "Elec. Rev." is continued in the issue of March 17, in which are described and illustrated the ozone generators of Ladd, Tisley, 1873; Boillot, 1873; Houzeau, 1872; Berthelot, and Brin, 1886. The article appears to be an excellent summary, and is well worth the attention of those especially interested in the subject. The issue of March 24 contains 13 illustrations of various forms of apparatus which had been suggested and used, among which are the later apparatus of Siemens & Halske.

## New Electric Lighting District in Paris.

More than a year ago a new electrical company obtained a franchise to light the district of the Champs-Elysees, and has just completed the installation of its plant. The station is situated about three-quarters of a mile outside of Paris, on the banks of the Seine. It consists of two large buildings, one for the boilers and the other for the engines and dynamos. The boilers are five in number, of the Galloway type, furnishing at 75 pounds pressure 6,000 pounds of steam per hour, and are fed by water taken directly from the Seine. The engines, to the number of three, are of the Corliss type, made by Farcot, of 700 h. p. at 60 revolutions a minute. Each of them is directly connected to a Hilliarat alternator of 400 kilowatts and 3,000 volts. The exciter, by the same constructor, is of the two-pole type, and gives 25 kilowatts with 150 volts, and 300 revolutions per minute, being run by a pulley on the shaft of the dynamo. The alternator has 80 poles, and the frequency or number of periods per second is therefore 40. The armature is fixed and the field revolves. The alternators are to be coupled in quantity. The conductors are under ground, and of the lead-covered Berthoud-Borel system. They are buried directly in the earth in a bed of sand. The transformers are in the cellars of the customers.

## Electrical Progress in Germany.

*(From Our Special Correspondent.)*

A trial was recently made of the electric lighting of a railway carriage on the Berlin-Hamburg line in the presence of some high officials belonging to the railway and postal administrations. (The railways in Germany, as may be generally known, are almost all the property of the State; only a few small lines exist belonging to private companies.) Each compartment of the carriage is lighted by two incandescent lamps of 8-10 c. p., fixed under a glass shade in the centre of the carriage roof or on either side of the carriage, according to the conditions. The lamps are fed from two accumulator batteries, each consisting of 18 cells mounted in hermetically sealed ebonite boxes. The batteries are located underneath the carriage, either lengthwise or transversely as space permits. In order to provide sufficient illumination of the compartment in the event of a possible failure of either of the batteries or circuits, an arrangement is made by which the two lamps are each fed independently from a different battery. The light can be regulated as desired by the passengers, by simply moving a switch conveniently placed above the seats, the switch operating a resistance in the lamp circuits. The intensity of a lamp may be reduced in this way from 8 c. p. to 2 c. p. As the trial made proved perfectly satisfactory to all concerned, the railway administration will doubtless arrange for the general introduction of accumulator train lighting, as has already been done more or less extensively in other countries. In the opinion of the experts the cost of such electric lighting is now no greater than lighting by means of oil gas, and, if the system were generally adopted, it would undoubtedly be even cheaper. In this connection it may be mentioned that the electric lighting of some mail carriages was tried a few months back at the instance of the postal administration, and the results are said to have been equally satisfactory. The work was planned and carried out in both cases by a local firm.

Messrs. Siemens & Halske's scheme of an elevated electric railway system for Berlin is creating very general interest, and the press discusses the question at length from various standpoints. The public appear to be agreed as to the desirability of better means of communication than exist at present between different portions of the city, particularly between the centre and the west end, and all opposition to the project on the part of house and property owners has been entirely withdrawn. The reason for this change of front is that some misapprehension existed as to the kind of overhead structures proposed for the electric line; it was thought that it would be similar to the existing steam city and circle railways. These lines run over viaducts of solid brick work, and as the ordinary heavy main line coaches are used for the local trains there is necessarily a good deal of noise. But with electricity as the motive power both trains and viaducts would be lighter, and the latter (a general description of which was given in The Electrical World of Nov. 26, 1892) would, in addition, be so constructed as to reduce all noise to a minimum. The necessary funds, which are, of course, pretty considerable, are said to be already assured, and Messrs. Siemens & Halske are only waiting for the concession to be granted before going ahead with the work.

Despite the fact that accumulator traction has been pretty generally proved not to pay, the question is resuscitated every now and again for the especial benefit, apparently, of the doubting investor, and as a means whereby to test his progress as a dreamer of dreams in which self-contained cars become synonymous with big dividends. Such a revival is now taking place here, where the Berlin Grand Tramway Company proposes to introduce accumulator traction, by way of an experiment, be it said, on one of its lines. The company has, as a matter of fact, been thinking more or less about electric traction in general for a long time. In 1891 it got so far as to cause delegates to be sent to view and report upon the Siemens conduit road in Budapest; and it seemed at the time as though something were really going to be done. But nothing much was done. The tramway company all at once stopped thinking about electric traction and the horse cars run just as if nobody had ever thought of disturbing them.

Another street car company here, the old Berlin-Charlottenburg Company, is wrestling with the same question. In this case, however, it is not so much the progressive spirit as it is the force of circumstances that is impelling the company to look to the power of the future for the working of its road. The concession for the Charlottenburg section of the line will expire next year, and the local authorities have intimated to the directors of the tramway company that they would only be disposed to grant a prolongation of the concession on condition that electricity become the motive power. Negotiations with Siemens & Halske as to the application of electric traction to the line were pending while Werner von Siemens was alive; and they have now been concluded. It has yet to be decided whether the overhead conductor system or the conduit system will be adopted; and this question creates a difficulty aside from its own merits, in that part of the line is within the boundary of Berlin, where the overhead system will certainly not be permitted, except, perhaps, along the Charlottenburg Chaussee, which commences just outside the Brandenburger Thor, the Arc de Triomphe of Berlin. Whichever way the question may be settled, it is probable that the work will be carried out, and sooner than the projected electric elevated railway, of which mention has been made on other occasions.

The question of an electric underground railway for Berlin comes up from time to time, emulating in its chimerical brightness the English Channel tunnel scheme. The original project dates from the autumn of 1891. Whether it has been under a sort of passive consideration since then is not quite clear; anyway, the authorities now state that the project can only be definitely considered after its feasibility has been proved. The Allgemeine Company has accordingly prepared a scheme with this object embracing the following: 1. The sinking of a shaft in which a lift is to work between the street surface and the underground line. 2. The complete equipment of a section of the railway tunnel, in length about 100 yards. 3. The building of a passenger tunnel, in length about 30 yards. These preliminary works are to become part of the completed system later. The company has chosen for the same a part of the northern end of the Friedrichstrasse, in view of the fact that it would be a suitable point for a station, as it forms the junction of three streets, and the situation is particularly favorable, inasmuch as it is readily accessible, and the work would not cause any suspension of the street traffic. Application has been made to the authorities for the concession, and it is hoped that no obstacle will be placed in the way of its being granted.

The Berliner Elektricitaetswerke has reduced the rate for current supplied for industrial purposes to 5 cents per kilowatt-hour. As one mechanical horse power requires with economical running motors 800 to 900 watts, according to their size, the horse power-hour at full load costs about 4 to 5 cents. Experience has shown, however, that full load can only be assumed to be on during, at the most, half the running time, and as with motors of the kind referred to the efficiency is maintained almost constant up to this limit, the average cost of the nominal horse power amounts to something like 2 to 2½ cents.

At a recent meeting of the Berlin Electrotechnical Society, Prof. Dr. Slaby read a paper on a new method of electric welding, and made some experiments with the apparatus described, which were very successful. The official report of the meeting has not yet appeared, so that no details are to hand at the moment.

## An Interesting Point.

BY A. B. UPHAM.

Can wornout incandescent lamps be repaired and sold without infringement upon the patents under which they were originally manufactured? This is the interesting query propounded in The Electrical World of March 11, 1893.

At first thought one is tempted to declare there is no infringement. The original article, having once been sold by the patentee thereof, or by his duly authorized agents, has passed out of his possession and is now the exclusive property of the purchaser. Hence, as a man should be able to do what he pleases with his own, he should have the right to repair and use again his own property. This appears to be axiomatic. But it has some exceptions.

Suppose a man buys a hektograph. Has he a right, when the gelatine becomes incapable of further use, to renew it himself? The tray is his own property; should he not be allowed to refill it? The laws says no, for the reason that the patent covered the process, and this process would be infringed by the act of compounding the gelatine pad.

This simple case shows that if the repairs of exhausted incandescent lamps infringed upon any patented steps in the art of their manufacture, such renewing is an infraction of the law. If, however, there happen to be no process patents, and the manufacturers depend for protection upon claims covering the article itself, the case cited does not apply.

Our best course is to refer to the former decisions of the courts. One which seems to make the matter clear is this: An inventor had a patent covering the combination of a particular lamp burner and chimney. Certain manufacturers made and sold the burner alone, and claimed non-infringement.

Their defense was based upon the facts of the patent covering a particular combination, and their not making that complete combination. The courts, however, decided against them, holding that inasmuch as the burners could only be used when put in combination with the chimney, they were clearly infringers upon the patent.

In the same way, the person who takes certain elements and combines them to form a complete and patented whole is equally an infringer upon such patent, whether each of the combined elements be perfectly new or one or more are second hand. The patented article, in the case of the incandescent lamp, consists essentially of the combination of the exhausted bulb and the filament therein. No unauthorized individual has a right to make such a combination of elements. He may make the bulbs himself, he may buy them from others or he may take old bulbs previously used by himself or others; it makes no difference. When he combines with such bulbs the carbon filament, exhausts the air therefrom and forms a complete lamp, he is in each case an infringer upon the patent.

Moreover, in accordance with the decision above referred to, the unauthorized manufacture or sale of bulbs to be combined by other unauthorized parties into incandescent lamps can be enjoined by the courts.

## Central Electric Lighting Stations in Massachusetts.

The eighth annual report of the Board of Gas and Electric Light Commissioners of the State of Massachusetts contains much valuable statistical information relating to central station electric lighting, from which we compile the following as of particular interest.

Number of electric lights of various candle power representing the dynamo capacity of central stations June 30, 1890, 1891, 1892 is as follows:

| | 1890. | 1891. | 1892. |
|---|---|---|---|
| 16 c. p. | 140,870 | 181,270 | 214 700 |
| 20 " | 1,700 | 8,530 | 900 |
| 25 " | | | 600 |
| 15 " | 880 | 836 | 836 |
| 2 000 " | 8,425 | 8,401 | 9,633 |
| 1,000 " | 6 085 | 6,447 | 8,499 |
| 1,600 " | 60 | 160 | 160 |
| 1,200 " | 60 | 60 | 60 |
| 1,500 " | 40 | 200 | 35 |
| 1,700 " | | | 125 |
| 800 " | 70 | 70 | 70 |

MOTORS FURNISHED OFF VARIOUS CIRCUITS (1892).

| | Number | Horse power. |
|---|---|---|
| Arc circuit | 114 | 6,930. |
| Incandescent circuit | 1,294 | |
| Power circuit | 376 | |

Aggregates from the balance sheets of the electric companies only, taken from the returns of 1891 and 1892, show the following facts:

| | 1891. | 1892. |
|---|---|---|
| ASSETS. | | |
| Construction accounts, including patent rights and franchises | $9,031,520.49 | $11,097,808.20 |
| Cash on hand | 262,284.10 | 419 639.58 |
| Due for light and power | 178,034.22 | 238,708.79 |
| Other accounts due | 67,475.82 | 68,026.85 |
| Materials, etc | 240,933 02 | 460,153.63 |
| Notes receiveable | 84,269.09 | 69,229.09 |
| Investments | 67,370.91 | 85,291.10 |
| | $9.931.887.66 | $12,138,857.19 |
| LIABILITIES. | | |
| Capital | $5,866,300.00 | $6.539,700.00 |
| Bonds | 1.923,125.00 | 2,548.050.00 |
| Notes payable | 1,243,349.96 | 1,767.907.27 |
| Unpaid bills | 374.818.77 | 557,947.76 |
| Unpaid dividends | 438.07 | 2.462.48 |
| Interest due and unpaid | 11.374.50 | 29,991.06 |
| Other items | 37,654 81 | 345,831 67 |
| | $9,457,061.11 | $11,791,890.24 |
| Reserved and depreciation funds | 80,249.97 | 132,825.32 |
| | $9,537,311.08 | $11,924,715.56 |
| Surplus | 394,576.58 | 514,141.63 |
| | $9,931,887.66 | $12,438,857.19 |
| Of these companies | | |
| 39 show an aggregate surplus of | $426,759.95 | $578,266.71 |
| 17 show on aggregate deficit of | 32,183.37 | 64,125.08 |
| Leaving total net surplus, as shown above | $394,576.58 | $514,141.63 |
| Which, added to reserves carried as liabilities | 80,249 97 | 132,825.32 |
| Would show an actual surplus of | $474,826.55 | $646,966.95 |
| Equivalent to per cent. on capital of about | 9 | 9⅝ |

RESULTS OF OPERATION.

| | Year ending June 30. | |
|---|---|---|
| | 1891. | 189?. |
| RECEIPTS. | | |
| For light and power | $2,432,869 15 | $2,917,199.64 |
| From other sources | 7.481.50 | 23,438.30 |
| | $2.440,350.65 | $2,970,637.94 |
| EXPENSES. | | |
| For manufacture | $1,014,242.88 | [1]$1,156,320.69 |
| Distribution | 356,332.38 | [2]386,084.45 |
| Office expenses and management | 159,236.90 | [3]194 999.25 |
| Taxes | 82,743 77 | [4]107,291.15 |
| Miscellaneous | 122,656.20 | [5]170,707.32 |
| | $1,735,206 13 | $2,015,402.86 |
| Leaving a balance of | $705,144.52 | $955,235 08 |
| Of this profit, the gas companies made in their electrical departments | 143,240.78 | 189,225.74 |
| Leaving for the electric light companies | $561,903.74 | $766,009.34 |
| To which should be added the income from rents, jobbing, etc., amounting to | 45,022.10 | 195,280.73 |
| Making a total of | $606 925.84 | $961,290.07 |
| Against which the following charges were made: | | |
| Interest | $144.678.87 | $195,094.15 |
| Dividends | 262,968.00 | 323,581.00 |
| Depreciation | 41,225.21 | 210,168.79 |
| Sundry items | 7,671.57 | 32,227.49 |
| | $456,513.65 | $761,071.43 |
| Leaving a surplus to be carried forward of | $150.382.19 | $200,218 64 |

[1] 57 per cent.; [2] 19 per cent.; [3] 10 per cent.; [4] 5 per cent; [5] 9 per cent.

Of the 56 central station companies in the State, 33 paid no dividends and 23 paid an aggregate of $323,580, as follows:

| No of companies. | Dividends. | Amount. |
|---|---|---|
| 4 | 8 per cent. | $41,804 |
| 4 | 7 " | 197,587 |
| 9 | 6 " | 76,155 |
| 3 | 4 " | 5,650 |
| 1 | 2½ " | 1,467 |
| 1 | 2 " | 2,384 |
| 1 | 1½ " | 225 |

## Electricity at the World's Fair.

The exhibits in the Electricity Building are being received with great rapidity. Some of the German exhibits are already on hand. The English are expected soon. Of the American exhibitors, many are making much progress. The General Electric Company has a number of machines on hand and set up in place. Several of the exhibitors are erecting large structures in which to display their exhibits. There seems to be a tendency among these to combine the representation of the civilization of the nineteenth century with that of the most ancient, by housing their electrical exhibits in structures copied from ancient models. The Western Electric Company have inclosed their exhibit by a large Egyptian pylon, and the Bell Telephone Company have erected a large structure of Greek architecture, both of these assuming to be of heavy masonry, though in reality nothing but the prevailing deception of staff work on a basis of pine studding.

The most prominent feature in the Electricity Building will be the Edison column, which occupies the central portion of the building, and is a combined exhibit from the General Electric Company, the Phoenix Glass Company and Mr. Edison himself. This column, which was illustrated in the last issue of The Electrical World, is intended as a sort of glorification of the incandescent light, and at night the spirals of incandescent lights will be turned on alternately, so as to give a varying color. The base of the column will be surrounded by numerous exhibits relative to the progress and development of the incandescent lamp industry.

The Bell Telephone Building occupies a position at the extreme south end of the Electricity Building, and, though it may be criticised as being too substantial and massive to be placed inside of another one, yet from the opposite end of the Electricity Building it has an impressive effect. The company will exhibit in this various models of telephones, both old and new, representing all possible stages of the invention and completion of the modern electric telephone. The Western Union Telegraph Company will have a similar exhibit of the telegraph. They have as yet done but little work on their exhibit, though they assure the authorities that it will be ready for opening May 1.

In regard to the electrical apparatus in the power plant in Machinery Hall, a large amount has already been installed. The plant was really inaugurated about the middle of March, when the two 400 h. p. Westinghouse engines, with the incandescent dynamos which they drive, were first turned over. A few days later some of the Ball & Wood engines, driving the Brush arc machines, were started, and a day or two after this one of the Woodbury engines, driving two Mather power generators, was put in operation. These machines sufficed to take the place of the old temporary power plant, which is now being torn down. The Standard and Ft. Wayne dynamos are all in place, and the Thomson-Houston and Western Electric Company are being located. All of the bases, and all but one or two of the field magnets of the Westinghouse dynamos, have been received, and are set up. Eight of the armatures are on the ground, and four are in place. Three of the Westinghouse engines were received last week, and the other three are following as rapidly as it is possible to ship them. The big Allis engine is all erected except the flywheel, and this is now on the ground. About three-fourths of the piping for the plant has been placed, and there is every reason to expect that it will be all completed for the opening. The outlook on the whole is most favorable for finishing the work in connection with the power plant on time.

## Meeting of the Societe Internationale des Electriciens at Paris.

At the last meeting of the society, which took place on March 1, several interesting questions were discussed. M. Cance first described the new electric light installation of the St. Lazare railway station, which comprises 250 Cance arcs of 6, 8 and 10 amperes on a 70-volt circuit, and 2,600 incandescent lamps. M. Hospitalier next outlined the programme proposed by the American Institute of Electrical Engineers for the Congress of Electricians for 1893, and drew attention to the advisability of thoroughly discussing in advance all the questions in order to come to useful conclusions when they are finally considered by the Congress. It will be especially necessary, he stated, to pay attention to the phraseology of alternating currents. M. Blondel commenced the discussion. He considered it desirable to suppress the words "effective" and "impressed," which are now used so much in connection with electromotive force, as well as the word "voltage," which has little or no value. There is no reason for replacing the word "inductivity" by the word "permeability." The definition of self-induction is false. For the unit of light there is the word lux and the Violle-metre, but it is preferable to retain the candle at one metre. For the standard of light M. Blondel criticised severely the Hafner acetate of amyl-standard. He prefers for the laboratory the standard of M. Violle. As to the measurement of arc lamps, it will be convenient to refer all the measures to a lamp chosen as standard. In some experiments of M. Chatelier, M. Blondel discovered that the intensity of the light of the arc crater (+) is reasonably constant notwithstanding the temperature. M. Guillaume next made some interesting remarks as follows:

The American proposals may be divided into two categories: (1) Definitions of new units and terms, and a unification of the vocabulary and notation. (2) Sanction of the values of the legal standards. The first are within the competence of a congress; the latter belongs to an official conference. As regards the first, a congress may come to a decision; as regards the latter, it can only express its wishes, of which, no doubt, a conference or a diplomatic assembly would take cognizance, though only to the extent it deemed convenient. It will not be without advantage if we clarify our ideas on this question, either at the congress or, better still, by preliminary discussion.

The first thing to be done is to adopt a fixed rule for the termination of words denoting the same category of physical properties. For instance, conductibility, malleability and permeability are incontestably properties of certain substances, and are independent of the shape or amount. Resistance is a property of a conductor depending on its substance and shape. Speaking generally, the English have already adopted the words conductance and permeance, the form of which is absolutely French, so that they will be neologisms for our language, and not barbarisms like self-induction, shunt, spot, which have nevertheless been only too widely adopted in France. We should then have the following table:

| Properties of matter. | | Values depending on the shape of a body. | |
|---|---|---|---|
| Resistibility | $[\alpha]$ | Resistance | $[R] = [\alpha L^{-1}]$ |
| Conductibility | $[\gamma]$ | Conductance | $[T] = [\gamma L]$ |
| Permeability | $[\mu]$ | Permeance | $[P] = [\mu L]$ |
| Reluctability | $[\rho]$ | Reluctance | $[R] = [\rho L^{-1}]$ |

In the same way inductibility and inductance, though it would be convenient to define the meaning of the term induction, which is employed in very different senses.* Two meanings would be suppressed by reserving the term flux of force for total induction, while magnetic induction, as generally understood, would logically mean density of flux, a term already employed. The word conductance, to which many electricians find it difficult to get accustomed, would simplify matters considerably; we should enunciate the well-known theorems, in fact, in the following way: "The total resistance of a series circuit is equal to the sum of the resistances of the circuit." "The total conductance of a parallel circuit is equal to the sum of the conductances of the parallel circuit." The unit of conductance exists, it is the mho. Resistance will always have its raison d'etre in science, but in commerce it is conductance which will become, in the case of distributing networks, the important magnitude; mhos, not ohms, will be spoken of one day in connection with distribution networks. The mhos of a circuit indicate its efficacy. A circuit of n mhos will allow n amperes per volt.

The American Institute has proposed a unit of magnetic field, the gauss $= 10^8$ C. G. S.; and a unit of flux of force, the weber $= 10^8$ C. G. S. These two units, unrealizable up to the present, only have their raison d'etre because they form part of the coherent system already adopted. Such, indeed, was the reason for the adoption of the farad. The weber per second is a volt. But then there is no cause for adopting as the unit of magnetomotive force anything else than $10^8$ C. G. S. units; since the magnetomotive force is equal to the field multiplied by a length, the unit of force should be the gauss centimetre, and not one-tenth C. G. S. If we sacrifice the C. G. S. system it should be in favor of the coherent system; another intermediary system would only confuse our ideas.

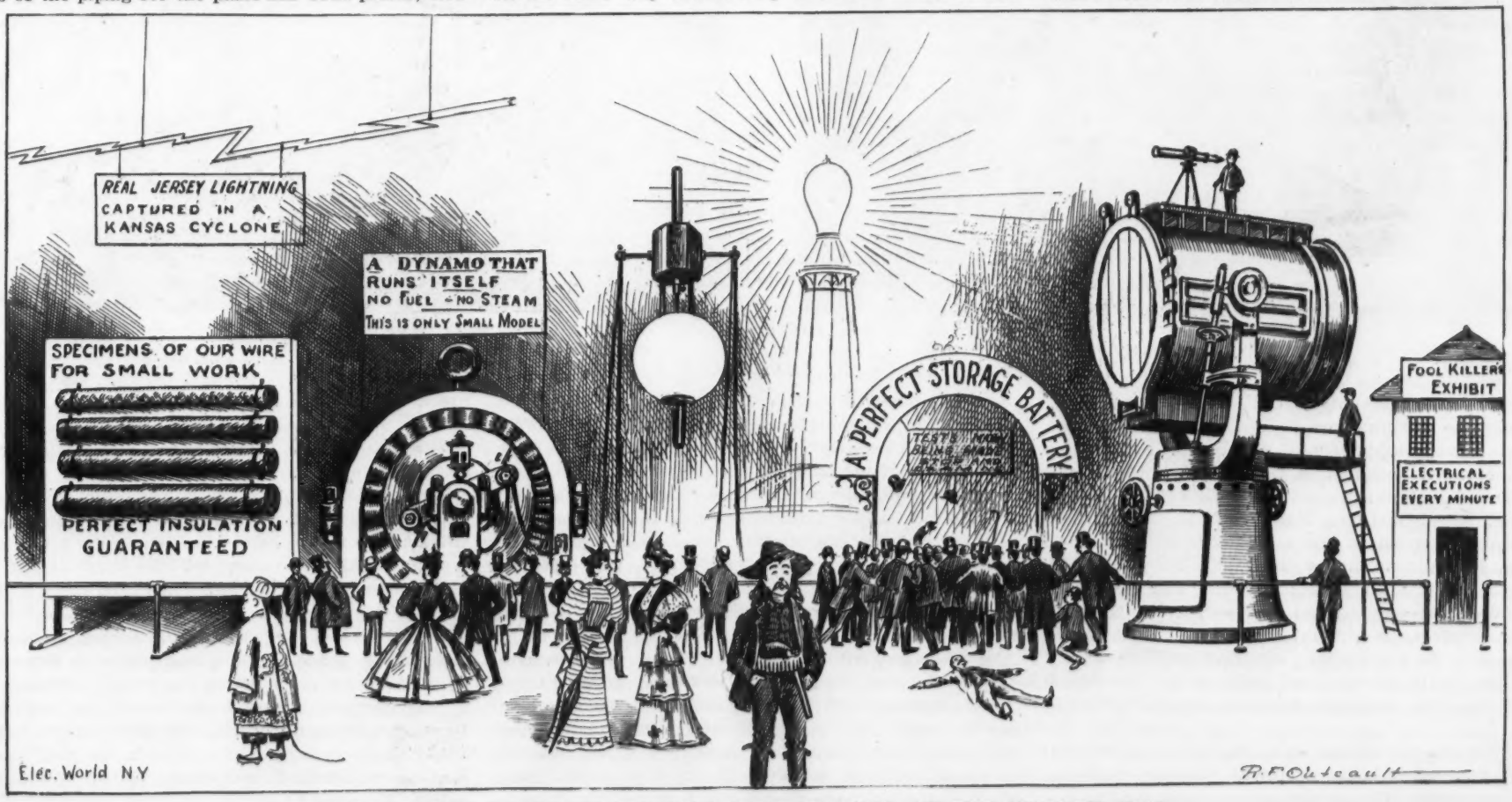
As regards material standards, I will call attention first of all to a misunderstanding in our Bulletin. It is not a question of bringing the mass of silver deposited in the voltameter into relation with the gramme weight; we can effectively compare by means of a balance the weight of the deposit with the standard weight, but it is a question of deducing the mass of the deposit, the value of g eliminating itself and the corrections for pressure, etc., being easily carried out. In fact, we obtain the mass without any correction by balancing the platinum cup with platinum, and weighing the deposit with silver weights (gilded or platinized).

Without wishing to discuss matters which are, as I have said, beyond the competence of the congress, I may observe that after the conference of 1884 the English retained the B. A. U., the Germans the Siemens unit, and that in France we were divided between the legal ohm and the B. A. U. To-day the English give up the B. A. U., not merely as unit, but even as standard. The first proposal was, indeed, to define the new ohm as $\frac{1}{0.9864}$ B. A. U. But after the Edinburgh Congress, to which foreigners were invited, the English unreservedly withdrew their standard, and now define the ohm as the resistance of a column of mercury of 106.3 cm. etc. The German bill just published contains the same proposal, and it is much to be desired that France should also adopt the new ohm. It is so approximately equal to the theoretical ohm that, instead of the B. A. U., the S. E. (Siemens'sche Einheit), the legal ohm and the true ohm, which are at present in existence, we shall only have for a long time to come a single ohm, at the same time true and legal—the 106.3 ohm. Later on, perhaps, there will be grounds for departing from this value, but only very special cases. The reform will be effected without any one noticing it, since resistance box makers have taken time by the forelock. The majority of the german silver standards constructed of late years have been equal to or more than the 106.3. The adoption of the new ohm will be an excellent question to restandardize them.†

The discussion will be continued at the next meeting.

*The repor' proposes to adopt the term inductivity as a synonym for permeability; one of the two would then play two parts. The latter, very convenient in practice, has, perhaps, the defect of recalling too exclusively a certain theory of magnetism.

†I should even see no disadvantage in keeping the name legal ohm for the new ohm, if for a year or two the figures 1893, or perhaps 106.3, are added in parenthesis. In this way we should avoid all confusion, and should not burden ourselves for the future with a new and useless word. On the other hand, the name true ohm could be retained for the theoretical ohm.




SOME OF THE THINGS WHICH WE EXPECT TO SEE AT THE WORLD'S FAIR.

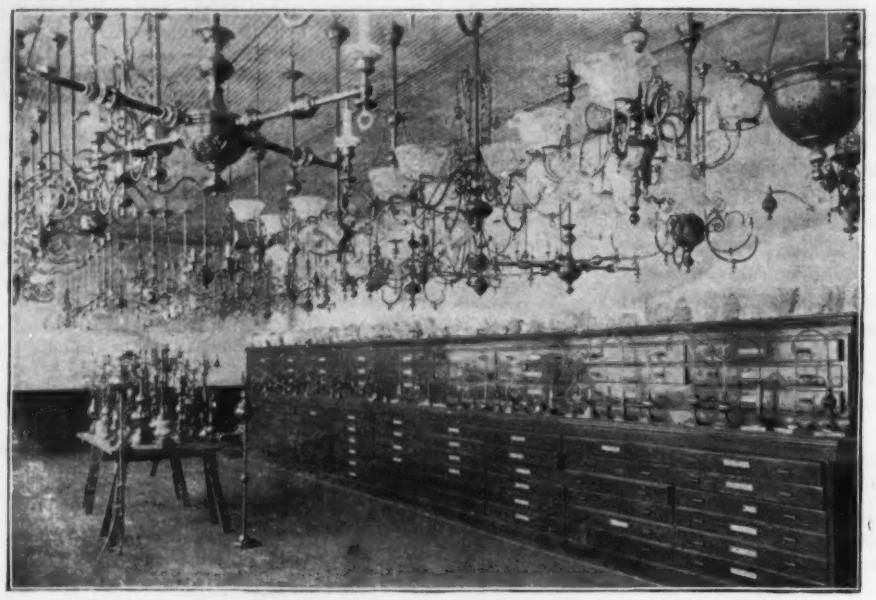
### The Great Western Electric Supply Company.

One of the largest consolidations which has recently taken place is that which resulted in the present Great Western Electric Supply Company of Chicago. As reorganized, this company includes the following companies: The Great Western Electric Supply Company, of Chicago, Ill.; The Chicago Insulated Wire Company, Sycamore, Ill.; The Bain Electric Manufacturing Company, Chicago, Ill.; The Phoenix Manufacturing Company, Duluth, Minn.; The Great Western Electric Supply Company, St. Louis, Mo. The organization was completed on Jan. 13, 1893, with a paid-in capital of $1,500,000, of which $1,300,000 was common stock and $200,000 preferred.

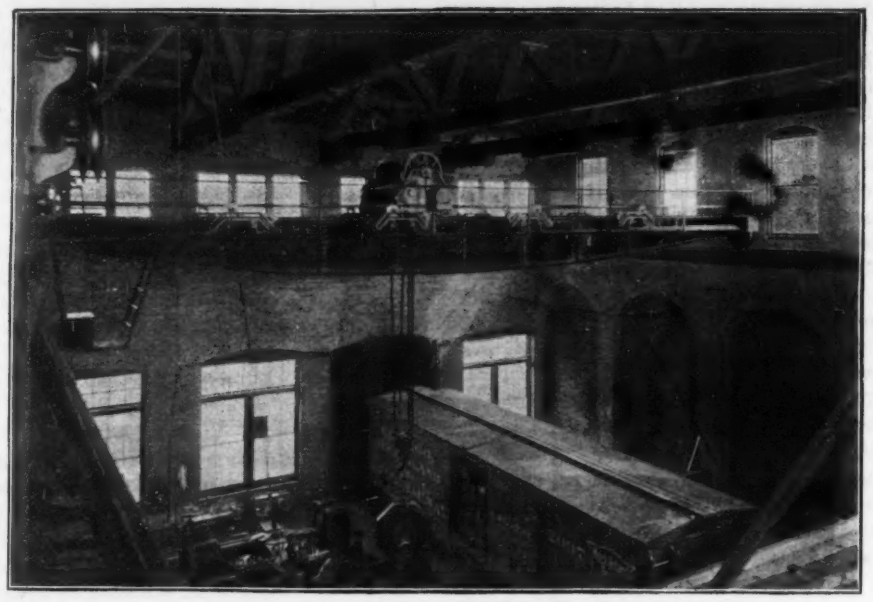
The Great Western Electric Supply Company, organized in the spring of 1889, at first did a jobbing business only, with headquarters at 190 and 192 Fifth avenue, Chicago, but soon entered the manufacturing field and opened a shop at 195 South Canal street. It soon became necessary to greatly increase the manufacturing facilities, and the entire establishment was moved to its present site, 195 to 207 South Canal street. Less than a year ago the corporation became interested in the Chicago Insulated Wire Company, and has lately purchased all the stock of that concern, which now occupies its own building at Sycamore, Ill., and has in operation over 300 machines for the insulation of wire. The Phoenix Manufacturing Company, of Duluth, Minn., was in like manner absorbed, and later the Bain Electric Manufacturing Company was taken into the combination, and all its machinery, tools and supplies removed to the Duluth factory. The Western Electric Supply Company had for some time been virtually under the management of the Great Western Electric Supply Company.

The officers of the new company are as follows: President, T. B. Casey, formerly the vice-president and now director of the Northwestern National Bank, Minneapolis, Minn.; first vice-president and managing director is R. S. Munger, president of the Imperial Mills Company, Duluth, Minn.; second vice-president, Stephen J. Young, president Union National Bank, Brunswick, Me.; third vice-president and assistant treasurer, O. H. Simonds, general manager of the Duluth Terminal Railway Company, Duluth, Minn.; secretary and treasurer, H. A. Odell, Chicago; general manager, E. R. Gilman, formerly president Northwest Thomson-Houston Electric Company, St. Paul, Minn.; electrical engineer, Foree Bain. The list of stockholders includes the names of some of the most prominent business men in the country.

E. R. Gilman, the general manager, is well known as the former president of the Northwest Thomson-Houston Electric Company. He entered the electrical field in its early days and his business ability has been proved by the marked success which has followed his efforts. The president of the company, Mr. Casey, is well known throughout the Northwest as a conservative business man and banker. He is a man of large means and was formerly vice-president of the Northwestern National Bank, of Minneapolis. Mr. Munger, first vice-president, is the president of the Imperial Mills Company, of Duluth, which is said to own the largest flouring mill in the world. Mr. Munger is also interested in many of the leading enterprises in Duluth and vicinity. Hon. Stephen J. Young, second vice-president, is president of the Union National Bank at Brunswick, Me., and is as well known in the East as Messrs. Casey and Munger in the West. Mr. Simonds, third vice-president, is general manager of the West Duluth Land Improvement Company, and manager of the Duluth Belt Line Railway. He is possessed of indefatigable energy and excellent business ability. Mr. Odell, the treasurer, is a gentleman who has had a thorough business training, although a lawyer by profession, and is well fitted to fill his new position. H. K. Gilman, for several years the active head of the Great Western Electric Supply Company, will be manager of the Chicago office and have general charge of the factories. Mr. Gilman is well known to the electrical fraternity throughout the West, and he will bring to the new company the administrative ability which has contributed so largely to the success of the Supply Company. T. C. Rafferty is assistant general manager, and has complete charge of the sales department. J. L. Parmelee continues in charge of the fixtures department as heretofore. R. V. Scudder is manager of the St. Louis house, and has already built up a good business.



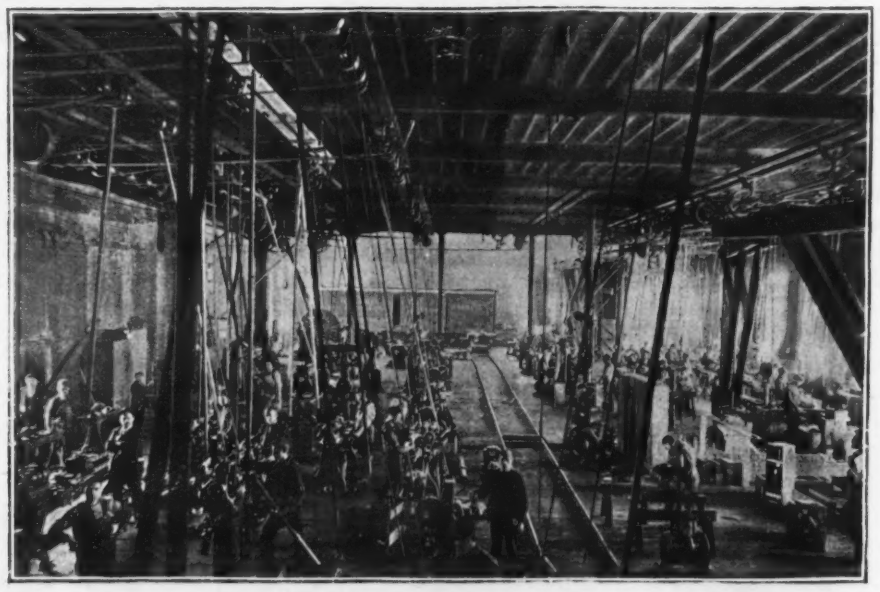
Fixtures Salesroom.



Electric Crane in Machine Shop.

THE GREAT WESTERN ELECTRIC SUPPLY COMPANY'S FACTORY.

Fixtures Factory.



Machine Shop.

THE GREAT WESTERN ELECTRIC SUPPLY COMPANY'S FACTORY.

The works are located in West Duluth, Minn., on the corner of Fourth avenue east and Fourth street north. The principal building is of brick, L-shaped, with street frontages of 457 and 200 feet. The corner portion is four stories high with an attic, and the wings are respectively one and two stories high and 60 and 75 feet deep. In addition there are two other large buildings, and several small ones; one of which, 200×75 feet, will probably be used for the wire factory, and the other, which has dimensions of 175×60 feet, will serve simply as a warehouse.

An inspection of the accompanying illustrations will show that the Duluth factory is well equipped for a large manufacturing business. Originally built for the Iron Bay Company the establishment was fitted with every appliance necessary for the manufacture of machinery of all kinds. Situated on the St. Louis Bay, at the head of navigation on Lake Superior, the factory is within a short distance of the great iron and copper mines of the Northwest, the products of which enter so largely into the manufacture of electrical machinery. Fuel is obtained at an unusually cheap rate, and the shipping facilities, both by rail and water, are excellent, as the tracks on the Duluth Belt Line Railway run directly into the factory. The factory is not yet running with a full force of men, but it is expected that, with all the departments in operation, 500 hands will be employed before the end of the year.

In the big factory power is supplied by three engines, one Corliss, with 14×30-inch cylinder, and two automatics, with cylinders respectively 6×10 inches and 10×20 inches. Steam is furnished by two tubular boilers 16 feet long and 5 feet in diameter, and the plant is rendered complete by a steam pump and feed water heater. There is also a pumping station, equipped with a 20-h. p. boiler, Knowles pump and Korting injector, water being taken from the St. Louis Bay. The dynamo equipment consists of five machines, a Thomson-Houston 250-light incandescent machine, and a Ball arc dynamo of 25-light capacity for lighting the building, a Sperry 50-lighter and a Thomson-Houston machine of 15-light capacity for testing arc lamps, and a small Eddy dynamo used for furnishing current in the plating room. The factory is completely equipped for machine work, the plant including a 10-ton Walker traveling crane, three 15-ton cranes in the foundry and three 10-ton cranes in the machine shop; 1,800 feet of shafting, about 30 lathes, as well as slotting machines, planers, etc. All the buildings are connected by tunnels. The two-storied wing contains the power plant, machine shop, fixture rooms and plating and polishing departments, while the foundry and blacksmith shop are in the eastern wing. The central portion is devoted to offices, show rooms, stock room and draughting department.

Foree Bain, one of the best equipped electrical engineers in Chicago, will have charge of the electrical work at the factory, and the Bain dynamo will be the type produced by the company. Mr. Bain has paid much attention to electrical mining machinery, being a pioneer in this field, and the company will devote special attention to this class of apparatus. The mining generator is especially designed to run a long period on full or varying load. Constant potential generators and motors will be manufactured in sizes having capacities varying from 10 to 200 kilowatts, wound for any voltage desirable, either shunt or compound. Within the next year the company will introduce the Bain system of alternating electric light machinery.

The insulated wire factory at Sycamore is a two-storied brick building 216 feet long and 48 feet wide. There are also two frame warehouses. Nearly all the operations of insulating wire are performed by machinery, and in the factory there are 160 braiders and 142 other machines. All the compounds, paints and waxes used are prepared on the premises. The capacity of the factory is from 35,000 to 40,000 pounds of wire a week, consisting of weatherproof, copper and iron wires, magnet wires of every description, and annunciator and office wires. Power is furnished by an Allis 40 h. p. engine, which also operates a 200 light Edison dynamo. The factory has been in operation something over a year and is doing a large business.

Arrangements have been made to build, and the work is at the present time progressing, a new insulating factory at the Duluth works. This will be equipped with the latest machinery and will be a model factory in every respect. There is also in prospect—in fact, plans have alread been drawn—for a wire-drawing mill to be located at the Duluth works.

### The Hart Flush Switch.

The Hart flush switch, illustrated herewith, which is manufactured by the Hart & Hegeman Manufacturing Company, Hartford, Conn., and has just been placed upon the market, has several points of merit. The general appearance of the switch when placed in position is neat and attractive, it being finished in any of the standard finishes, special finishes being furnished when desired. The switch proper is attached by two screws to a cast-brass plate, from which it is readily detached for wiring, and is protected from injury and dust by a surrounding brass shell attached to the back of the cast plate. The cast plate, with switch attached, is screwed to the wall, and a finished cover of heavy sheet metal with flanged edges is put on over the cast plate and held in position by the switch handle. No screw heads show on the surface of the finished cover, thus avoiding the necessity of special screws to match the finish of the cover. An assortment of finished head screws of different lengths to suit different requirements is unnecessary, for, as they are not exposed, common flat head screws of convenient length may be used for holding the plate to the wall. The flush plate shown is adapted for use with the regular "Hart snap switch" of the following sizes; five and ten ampere single-pole, ten ampere double-pole and ten ampere three-way.

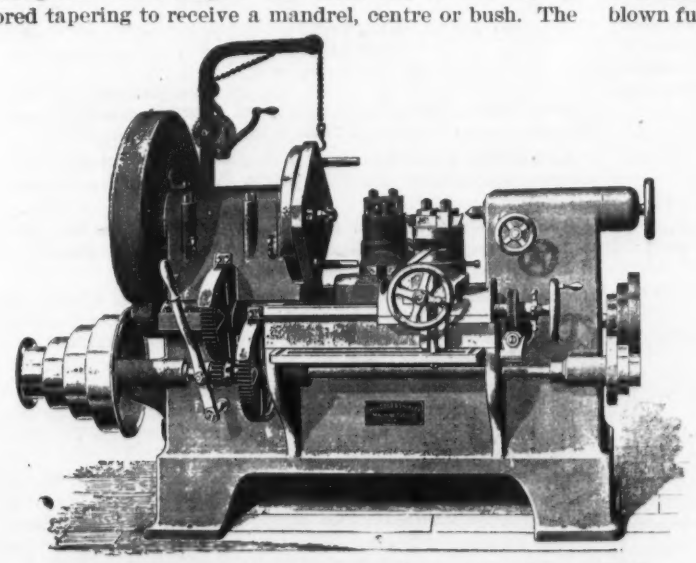
### The Lodge & Shipley 30-Inch Pulley Lathe.

The pulley lathe which is shown in the accompanying illustration is manufactured by the Lodge & Shipley Machine Tool Company, 86 to 92 Harrison street, Cincinnati, O., and is made to admit pulleys of 30-inch diameter with a 20-inch face, and will turn pulleys down to 9 inches in diameter. The entire frame of the machine is cast in one piece, including the head in which the spindle fits, the ways upon which the carriage is moved and the stop.

The power is taken from a 3½-inch belt by a large, four-step cone on the main driving shaft. The head spindle is driven from the main driving shaft by a train of six gears, which includes the back gear. The ratio between driving shaft and spindle is two to one with back gear out, and 30 to 1 with back gear in, thus giving a range of eight speeds from 2 to 180 revolutions per minute.

The gear on the head spindle is 30 inches in diameter. The spindle is 6 inches in diameter, with 3¾ inch hole through its entire length. The front end of this hole is bored tapering to receive a mandrel, centre or bush. The nose of the spindle is 9¾ inches in diameter, and threaded to receive a chuck or face plate. On the back of the head stock is a swinging crane for handling work in or out of the lathe.

. The saddles are driven by means of screws, in combination with bronze worm wheel, steel worm and friction. The front tool block is arranged to carry two tools, either of which may be revolved into position. This machine is furnished with countershaft, wrenches, etc., complete. Its total weight is about 4,500 pounds.

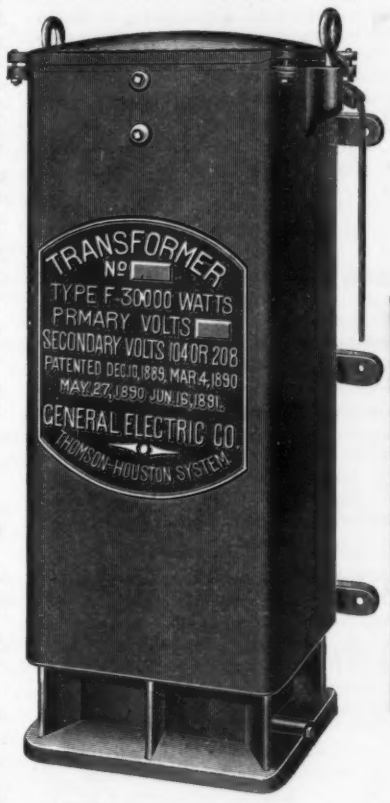


THE LODGE & SHIPLEY 30-INCH PULLEY LATHE.

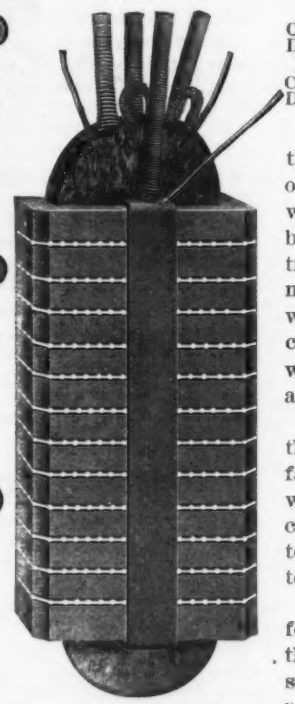
### The General Electric Company's Transformer System.

The essential characteristics of a good transformer are perfect safety, high efficiency, good regulation, small core loss and convenience of installation. In the "F" type of the General Electric Company's transformers, perfect safety is attained by insulating by the best mechanical means; by the use of oil as an additional insulation; by the provision of a core ground wire; by the subdivision of the primary and secondary coils, and by the absence of all fuses in the transformer case. The case is filled with a high grade of mineral oil, the coils and core being entirely immersed, with the result that should lightning strike one of these transformers, and injure the insulation in any way, the oil would immediately flow in and restore the apparatus to its original condition. These oil filled transformers have been subjected to numerous stringent tests, and it has been found necessary to increase the potential to more than 11,000 volts alternating before the insulation between the coils could be broken. After allowing the apparatus in which the insulation had just been broken by this high potential to stand a short time, the test was again applied, and not until the potential had been increased to over 5,000 volts alternating did the insulation give way the second time.

The core ground wire serves to render the transformer still more mechanically efficient, for should lightning break through the insulation of the primary coil it is carried at once to the earth, by the core wire, which should covered with rubber tube, and it has been shown by be carefully grounded. Furthermore, the primary coils are themselves subdivided. By this means, the greatest




30,000-VOLT TRANSFORMER.



INTERIOR OF LARGE TRANSFORMER

difference in potential existing between any two parts of the primary and secondary windings is only half the primary voltage, the secondary winding being the nearer to the core.

The absence of fuses in the transformer case obviates the necessity of opening the case, and eliminates whatever danger might be caused by the molten metal of the blown fuse. The fuses, in a separate box, non-combustible and waterproof, together with the primary switch, are placed in an easily accessible position. The fuses are actual test that where a certain potential will form and hold an arc in the open air across a space of 7 inches, the use of tubing hinders the formation of an arc under the same potential, even across the small space of 1¾ inches. On systems using potentials of over the regular 1,040 volts, two single-pole boxes are employed.

The efficiency obtained in this transformer has been shown by exhaustive test to be as high, if not higher, than any yet obtained, and an excellent average at all loads. It will be seen by the following table that the larger the transformer, the greater is its efficiency:

| Watt capacity. | Efficiency in per cent. at ¼ load. | ½ load. | ¾ load. | Full load. |
|---|---|---|---|---|
| 600 | 84.1 | 90.95 | 93. | 93.8 |
| 1,000 | 88.2 | 93. | 94. | 94.7 |
| 1,500 | 90. | 94. | 94.95 | 95.23 |
| 2,500 | 90.25 | 94.32 | 95.45 | 95.74 |
| 3,500 | 93.0 | 95.7 | 95.8 | 96. |
| 4,500 | 93.9 | 96.3 | 96.85 | 96 96 |
| 7,500 | 92.2 | 95 8 | 96.4 | 96.85 |
| 15,000 | 91.5 | 95.3 | 96.3 | 96.5 |
| 30,000 | 93.3 | 95.9 | 96.8 | 97.2 |

Practical uniformity of potential on the secondary winding throughout the range from full load to light load has been given much attention, with the result that the transformer gives no greater drop in potential than that shown in the following table:

| Transformer. | 52-volt secondary. | | | | | | |
|---|---|---|---|---|---|---|---|
| Capacity in watts | 600 | 1,000 | 1,500 | 2,500 | 3,500 | 4,500 | 7,500 |
| Drop of potential in volts | 1.09 | 1.21 | 1.35 | 1.43 | 1.5 | 1.5 | 1.6 |
| Transformer. | 104-volt secondary. | | | | | | |
| Capacity in watts | 15,000 | | | | | | 30,000 |
| Drop of potential in volts | 3 | | | | | | 3 |

The tendency of present practice is the substitution of a few large units for a large number of small ones, at points having a sufficient number of lights to warrant this step. The larger transformers constructed by the General Electric Company are designed for a transformation of 15,000 and 30,000 watts. Their size necessitates a subdivision of winding. In the 15,000 watt transformer both the secondary and the primary coils are each subdivided into two parts; in the 30,000 watt transformer the primary winding consists of three and the secondary of two separate coils.

The illustrations show the method of construction of the transformers. The laminated core is securely fastened into the iron case by means of wooden wedges, which serve as insulation between the coils and the case. Each transformer is subjected to an insulation test of 5,000 volts before it is allowed to leave the factory.

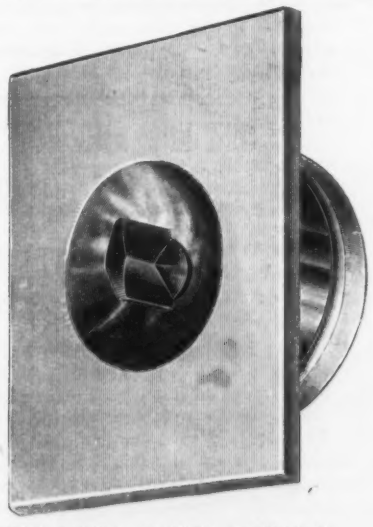
The advantages derivable from the use of large transformers are numerous. From a large transformer a three-wire system may be operated directly from its secondary terminals; and the advantage of using a high potential on the secondary winding where a large number of lamps are to be installed at one point can be shown as follows:

With 500 lights installed on several transformers in parallel, having a potential of 50 volts on their secondary wires, there is a drop of potential in the secondary system from no load to full load of about 6 per cent. The substitution of a large transformer, with its secondaries connected for 104 volt lamps on the three wire system, will reduce the drop in potential from 6 per cent. to about ½ of 1 per cent. This drop is far less than is necessary for satisfactory operation, and it is therefore possible to install the system for less than half the cost of a wire of a system with small transformers using a 52 volt potential and 6 per cent. drop.

The system of long distance transmission as employed by the General Electric Company is that of using generators, which give a potential of about 1,000 volts, and large transformers adapted to raise the potential to 5,000 volts or higher. The current thus transformed is transmitted over wires supported upon oil insulators, to the distant receiving point, and is there retransformed to an easily operable potential. The line insulator employed consists of a wide glass cup with an inner flange which dips into a ring shaped glass oil cup threaded onto the insulator pin. The transformers are the same as the standard type "F" transformer, except in the method of winding and insulating the coils. Both the primary and secondary coils of the long distance transformers are so wound as to secure the greatest possible inductive effect without any sacrifice of insulation. Mica is freely used, and the greatest care is taken both in winding and assembling to make the insulation as perfect as possible. This insulation is in all cases tested to withstand an alternating potential difference of at least 10,000 volts. The transformers are alike, with the exception of a modification in the winding, whether intended for "step up" or "step down" work, the primary of the "step up" corresponding to the secondary of the "step down." The standard size is 25,000 watts capacity, and larger sizes will be built if desired. It is not considered advisable, however, to build smaller sizes than this.




INTERIOR AND EXTERIOR OF SMALL TRANSFORMER.



THE HART FLUSH SWITCH.

## NEW INCORPORATIONS.

**The Canton Water Works and Electric Company,** New Orleans, La., capital stock $50,000, has been formed to build and operate water works and electric lights, etc. The promoters are H. D. Priestley, Irwin Jamison, N. C. Orrick and J. E. Cenas.

**The Alexandria Electric Light and Power Company,** Alexandria, Ind., capital stock, $30,000, has been formed to furnish electric lights for Alexandria, also for power purposes, etc James M. Barton, Cassius M. Greenlee and Jos. E. Jeffries are the incorporators.

**The Chicago, Niles and Norwood Rapid Transit Company,** Chicago, Ill., capital stock $500,000, has been formed to secure rights of way for electric roads and to furnish light, heat and power. F. A. Bingham, Robert Ceder and J. V. Maes are the promoters.

**The Speer Electric Transit Company,** Passaic, N. J., capital stock $100,000, has been formed to construct and build railways and cars. A. Speer, W. R. Brown, B. W. Spencer, R Morrell, H. H. Thompson, Passaic, N. J., and G. C. Mercer, Lodi, N. J., are the incorporators.

**The Coos and Grafton Electric Light, Heat and Power Company,** Lancaster, N. H., capital stock $50,000, has been formed to manufacture and distribute electricity. The promoters are J. W. Hopp, C. B. Dalton, Portland, Me.; N. H. Richardson, and W. R. Porter, Lancaster, N. H.

**The Stockton Power Transmission Plant,** Stockton, Cal., capital stock $1,000,000, has been incorporated to buy and sell all kinds of electrical machinery and appliances. The promoters are Louis Glass, San Francisco; Jos. Fyfe, I. S. Bostwick, H. J. Corcoran and S. D. Woods, of Stockton, Cal.

**The Holzer-Cabot Electric Company,** 92 Franklin street, Boston, Mass., in a recently issued catalogue describes in a very attractive way the various styles of apparatus which it manufactures, including fan motors, ventilating outfits, dynamos and motors, pressure indicators and controllers, etc.

**The Electrical Installation Company,** of Chicago, Ill., capital stock $25,000, has been formed to construct and operate dummy and electric street railways, to furnish light, heat and power, and to deal in all kinds of machinery, appliances, etc. The organizers are L. E. Myers, S. Fiansburg and David J. Wile.

**The Portable Electric Light and Power Company,** Peoria, Ill., capital stock $250,000, has been formed to manufacture, sell, etc., electrical inventions, batteries, motors and supplies for electric light and power plants, etc. Anson C. Tichenor, Robt. H. Walker, Isidore Mantz and Frank Cooly are the incorporators.

**The Speer Electric Transit Company,** Passaic, N. J., capital stock $100,000, has been formed to construct and build railways and cars according to plan and patents of Alfred Speer. A. Speer, W. R. Brown, B. W. Spencer, R. Morrell, H. H. Thompson, Passaic, and G. C. Mercer, of Lodi, N. J., are the parties interested.

**The Columbus Central Railway Company,** Columbus, O., capital stock $1,500,000, has been formed to contruct and operate a street railway in Columbus and Westerville, to be operated by electric or other power. J. J. Shiperd, Thomas Jopling, F. E. Merrick, John Ehrahardt and Ernest W. Radder are the promoters.

**The Columbia Traction Company,** Columbia, Pa., capital stock $10,000, has been formed to construct and operate motors and cables, etc., to passenger railways, and apparatus for same. The organizers are Wm. B. Given, F. S. Given, Columbia; Michael Reilly, Edward McGovern and John A. Coyle, all of Lancaster, Pa.

**The Miami Light and Power Company,** Kansas City, Mo., capital stock $40,000, has been formed to construct and operate electric light plants, street railways, etc., and to operate same by electric or other power. W. E. Helman, Paola; P. A. Folkener and Christie Bullock, Kansas City, Kan., are the parties interested.

**The People's Traction Company,** Philadelphia, Pa., capital stock $5,000,000, has been formed to construct and operate motors and cables or other machinery for supplying motor power to railways, etc. John Lawler Welsh, 1,420 Spruce street, Edw. J. Matthews and Caleb F. Fox, Philadelphia, Pa., are the promoters.

**The Neshobe Electric Company,** Brandon, Vt., capital stock $20,000, has been formed to install and operate systems for the production and distribution of electricity engineering, etc. E. D. Blackwell, Montpelier; W. H. Lang, Burlington; and E. D. Thayer and F. H. Farrington, of Brandon, Vt., are the parties interested.

**The Electrical and Mechanical Engineering and Trading Company,** New York City, capital stock $150,000, has been formed to act as contracting engineers for electrical or mechanical construction, or both. J. H. Vail, Westfield, N. J.; U. T. Fackerthall, Brooklyn, and J. H. Miller, Mt. Vernon, N. Y., are the promoters.

**The Electrical Conduit Traction Equipment Company,** Newark, N. J., capital stock $200,000, has been formed to manufacture and deal in all kinds of electrical appliances, etc. J. D. Griffen, J. C. Pearse, N. Y. City; W. C. Burling, A. K. Kearney, Brooklyn, N. Y., and E. S. Fuller, East Orange, N. J., are the organizers.

**The Direct Acting Electric Gong Company,** New York, N. Y., capital stock $15,000, has been started to manufacture and sell electrical and mechanical apparatus. Thos. Butler, 44 Broad street; Edmund A. Footman, 44 Broad street, New York City; and Henry B. Oakman, 453 Carlton avenue, Brooklyn, N. Y., are the parties interested.

**The Lancaster Traction Company,** Lancaster, Pa., capital stock $25,000, has been formed to construct and operate motors and cables or other machinery for supplying motive power to passenger railways, etc. A. S. Rohrer, B. J. McGrann, J. W. B. Bausman, Ed. McGovern, Lancaster, and Jas. Young, Middletown, Pa., are the interested parties.

**The Central and Consolidated Electric Company,** 68 Broad street, Elizabeth, N. J., capital stock $200,000, has been formed to manufacture and sell electrical goods, machinery, etc. The promoters are C. W. Gould, 22 West Thirty-third street, New York City; John L. Wilkie, Flushing, L. I., and Lloyd McK. Garrison, Orange, N. J.

**The International Trading and Electric Company,** Bayonne, N. J., capital stock $25,000, has been formed to act as consulting engineers, and to buy and sell merchandise, etc., for electrical plants. J. Armstrong, J. Armstrong, Jr., and Chas. Angus, Brooklyn, N. Y., and W. H. Fleming, Bergen Point, N. Y., are the promoters.

**The St. Mary's Electric Damper and Pressure Regulator Company,** of San Francisco, Cal., capital stock $100,000, has been formed with the intention of dealing in dampers, pressure regulators, etc. J. St. Mary, W. C. Starr, H. W. Case, all of San Francisco, and J. Preston Moore and John Collie, both of Oakland, Cal., are the promoters.

**The Brooklyn Traction Company,** of Brooklyn, N. Y., capital stock $10,000, has been formed to supply electrical or other power to railroads, etc. E. D. Phillips, 31 Beekman place, New York City; P. F. Vaughn, 336 Lexington avenue, Brooklyn, N. Y., and Albert Strauss, 124 West Ninety-seventh street, New York City, are the organizers.

**The Cincinnati & Dayton Electric Railroad Company,** Cincinnati, O., capital stock $100,000, has been formed to construct and operate a railway between that city and Dayton, to be operated by electric or other power. S. M. Felton, Wm. A. Goodman, L. C. Weir, Andrew Hickenlooper and Jos. B. Foraker are the interested parties.

**The Commonwealth Electric Company,** Camden, N. J., capital stock $100,000, has been incorporated to manufacture and construct dynamos, motors, lamps, machinery and appliances of every kind. L. B. Henry, Edington, O.; E. Malsby and Chas. C. Bockmeyer, of Philadelphia, Pa., and C. W. Wygand, Camden, N. J., are the parties interested.

**The Union Electric Light and Power Company,** Waterford, N. Y., capital stock $150,000, has been formed by the consolidation of the Union Electric Light and Power Company and the Waterford Electric Light and Power Company. The promoters are Wm. M. Lea, Lansingburg; Chas. McKallor, Watersford, and Horace C. Traib, Green Island, N. Y.

**The East Side Electric Company,** St. Paul, Minn., capital stock $25,000, has been formed to manufacture, generate and transmit electricity for light, heat and power purposes, and also to manufacture electric motors, dynamos and supplies of every description. C. Christadoro, J. H. Thompson, W. H. Ames and Oscar Hallam, all of St. Paul, are the promoters.

**The Richter Electric Company,** of Camden, N. J., capital stock $100,000, has been incorporated to manufacture dynamos, motors, arc and incandescent lamps, machinery and appliances of every kind to which electricity is applicable, etc. Chas. Richter, Camden, N. J.; S. M. Brice, Philadelphia, Pa., and Chas. C. Rianhard, Riverton, N. J., are the incorporators.

**The Ocean City Electric Railroad Company,** of Ocean City, N. J., capital stock $100,000, has been formed to supply electricity for street railway and other purposes. E. B. Lake, H. B. Adams, Wm. Lake, R. B. Stites, all of Ocean City; Jas. E. Lake, Keyport, N. J.; Gilbert E. Palen, Philadelphia, Pa., and S. Wesley Lake, of Burlington, N. J., are the incorporators.

**The Mineral Springs Mining and Improvement Company,** of Navasota, Tex., capital stock $150,000, has been formed to supply electric motor power, etc., etc. The incorporators are S. B. Rucker, T. C. Foster, S. M. Cook, R. Horlock, H. Schumacher, F. W. Brosig, J. H. Freeman, H. Woodward, A. Jones, R. Grimes, H. H. Boone, B. Goodman, H. A. Jacobs and I. M. Camp.

**The Cuero Electric Light, Power and Telephone Company,** of Cuero, Tex., capital stock $50,000, has been started to generate and supply electric light and power to the citizens of Cuero and vicinity and to maintain an electric telephone line in that city. The incorporators are Otto Staerker, Emil Leonarat, A. F. Palmie, Louis Keller and Paul Dornbluth, all of Cuero.

**The East St. Louis Belt Suburban Dummy or Electric Railroad Company,** East St. Louis, Ill., capital stock $500,000, has been formed to construct and operate a suburban or dummy electric railroad in East St. Louis, Venice, East Carondolet and Madison. Louis Gross, J. W. Renshaw, J. P. Slade, M. F. Geary, Henry Voss and W. H. Bennett are interested in this project.

# Special Correspondence.

## NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, April 10, 1893.

**The American Telephone and Telegraph Company,** which controls the long distance lines, has increased its capital stock from $5,000,000 to $7,000,000. This is the outcome of the gradual growth of construction.

**"The Postal Telegraph,"** J. Frank Howell, editor and manager, 120 Liberty street, New York City, is the successor to the *Electrical Message*, and, as its name indicates, is specially devoted to the interests of telegraphy and operators. Under the management of Mr. Howell it will no doubt meet with success.

**"The Way of Trusts."**—The New York *World*, which has been publishing a series of articles on trusts and their methods, in a recent issue devoted considerable space to the General Electric Company, which it held up as a horrible example. Tracing the origin of the company it proceeded to show how it was gradually extending its grasp over the entire electrical field. Nor, the writer stated, was the Westinghouse company any more virtuous: for it decried the action of the General Electric Company for business purposes purely. The consolidation of these two interests was confidently predicted.

## NEW ENGLAND NOTES

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., April 8, 1893.

**The Clinton Wire Cloth Company** will shortly install an isolated plant in its mills at Clinton, Mass.

**The Town of Athol, Mass.,** recently voted to have an electric light plant at a cost not to exceed $50,000.

**The citizens of Woodbury, Conn.,** have petitioned the House for the right to establish an electric railway system.

**It has been decided to light** the town of Guilford, Conn., by electricity and plans are under way looking toward the formation of a company.

**An electric road** will probably be built between Norway, Me., and Bridgeton, while the road from South Paris to Norway is already assured.

**A new electric street railway** line is to extend from the west end terminus, Oak Square, Brighton, and connect with the Newton electric systems.

**A company is being formed at** Laconia N. H., for the purpose of erecting a large power plant at Lakeport. The works will be operated by water power.

**The Consolidated Street Railway Company,** offices at 15 Market street, Worcester, Mass., will build a new electric power plant, to be operated by steam power.

**The North End Street Railway Company.** Worcester, Mass., will increase its capital to $110,000 to aid in extending the present terminus at Greendale to Clinton.

**The Chicopee Electric Light Company,** of which J. W. Cumnock is president and F. H. Norton secretary, will extend its electric light plant so as to enable them to furnish light for the streets of Willimansett, Mass.

**The Millis Electric Light Company,** of Millis, Mass., of which Mr. Appleyard is manager and purchasing agent, contemplates extending its electric light system for the purpose of lighting the streets of Medfield, Mass.

**E. V. Mitchell,** Jeremiah B. Hale and James Hewins, all of Medfield, Mass., are at the head of a company organized for the purpose of building a new electric light plant at that place. The selectmen have been petitioned for a franchise, and work will be begun as soon as the necessary permission has been granted.

**An Electric Railway** will probably be built to the Granite State Park, Dover, N. H., and the construction is expected to begin at once. P. S. Bryant, J. A. Stoughton and A. P. Moore have petitioned for the incorporation of a company to assume the name of the East Hartford Light and Power Company, of East Hartford, Conn.

**The Woonsocket Electric Machine and Power Company,** of Woonsocket, R. I., of which A. W. Buckland is president and A. C. Lincoln treasurer and general manager, has purchased the plant and franchises of the Franklin Electric Light Company, of Franklin, Mass. The plan will be improved, and the electric light system extended. The Woonsocket Electric Machine and Power Company will also build a new power house at Woonsocket.

## WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, April 8, 1893.

**George Cutter,** who has been spending the past month in the East, has accepted the Western agency for the tubes and railway insulators made by the Fiberite Company.

**The Central Electric Company,** of Chicago, reports an active demand for its Okonite wire, its new lamp socket, porcelain branch blocks, cut-outs and other supplies.

**The Ansonia Electric Company** (formerly the Electrical Supply Company) has recently closed a contract for a plant for municipal and commercial lighting in which a single alternating dynamo is to be used, and from one circuit will be run the Helios arc lamps for street lighting and incandescent lamps for interior illumination. Stanley transformers will be employed.

**The Western Union Ready to Fight.**—Officials of the Western Union Telegraph Company are wrought up over the crusade against their company, which they say has been begun by certain legislators at Springfield. They state that they are fully prepared to fight any sandbagging tactics. While they are willing to do anything reasonable, such bills as have recently been introduced into the legitiature are unconstitutional and will be fought by them.

CLEVELAND, Ohio, April 8, 1893.

**Port Clinton, O.,** is to have an electric railway.

**Arrangements** have about been completed for the construction of an electric road between Bucyrus and Galion, in this State.

**At Tiffin** electric cars began running regular trips on March 22. Within two months 12 miles of electric lines will be in operation.

**An Attempt** is being made to incorporate a company to build an electric railway between Zanesville and Mansfield, via Mt. Vernon.

**City Electrician Hoag** is preparing plans and maps for placing the electric wires under ground in the business portion of the city.

**The report** that the Cleveland company, which recently obtained a franchise in Cincinnati, will sell out to the Cincinnati Consolidated Company is strenously denied.

**A new schedule** put into effect on the electric railway at Ashtabula has resulted in a strike of motormen and conductors. The men say that the new schedule will compel them to work 16 hours a day.

**In the injunction suit** of the East Cleveland hamlet against the East Cleveland Railway Company, to prevent the company from laying a second track between Lake View and the junction of the Collinwood line on Euclid avenue, Judge Noble decided in favor of the East Cleveland Railroad Company.

**The City Council** at Martin's Ferry passed an ordinance on the 23d ult. granting a franchise through the town of Martin's Ferry to a company which proposes to build a road from Martin's Ferry to Bellaire and on out the National Pike. The county commissioners have already granted the right of way, and the Bridgeport and Bellaire councils are considering the matter.

## CANADIAN NOTES.

OTTAWA, April 8, 1893.

**Peterboro, Ont.,** is discussing an electric street railway. Messrs. Ahearn & Soper, of Ottawa, are figuring on the work.

**Application** has been made to the Dominion government for a charter incorporating the Auer Light Company with a capital of $1,000,000.

**Ottawa.**—The Dominion government has decided to drop altogether the project of a system of electric light inspection, which was prepared by an expert electrician.

**Waterloo, Ont.**—At a recent Council meeting a motion was carried permitting the Berlin & Waterloo Street Railway Company to change its present system to that of the trolley. The plant will shortly be in course of erection.

**St. Thomas.**—At a recent meeting of the City Council the Bell Telephone Company was granted an exclusive franchise for five years, and permission to erect poles on the street over forty feet high, on consideration of $245 a year.

**Montreal.**—Another electric company composed of Montreal, Toronto and New York capitalists is contemplated to run an electric railroad in Montreal. The capital required is six millions, a million and a half to be taken in Montreal. Works will be established in Toronto and Montreal.

**The London, Ont.,** city corporation is considering proposals from the Bell Telephone and Automatic Telephone companies, the former asking for an exclusive right for five years, and the latter seeking to gain an entrance to the city. For the privilege asked the Bell company offered to pay $5,000, or $1,000 a year; the Automatic company offered five per cent. on its gross receipts.

**The Pacific Telephone and Cable Company,** of Victoria, B. C., are applying for a charter, with a capital stock of $50,000, for constructing and operating lines of telephone and cable between the cities of Victoria, New Westminster, Nanaimo and Vancouver or intervening points, and between such places on Vancouver Island and Queen Charlotte Islands and such other islands in the Gulf of Georgia as may be desired,

**Toronto Junction.**—Some little time since the City Council was about to sell out the electric light system with exclusive franchise for 19 years to the Toronto Incandescent Company, but the C. & S. Electric Railway objected on the ground that it had the exclusive franchise under agreement with the town. With a view to ascertaining their position the Council referred the agreement to Judge Macdougall for his interpretation, who has given his decision to the effect that the Council is free to dispose of the franchise to whomsoever it chooses.

**The People's Electric Light Company,** Windsor, Ont., some time ago purchased the franchise of the Citizens' Electric Light Company, and it has also obtained the franchises of the Boomer and Sandwich & Windsor street railways. The roads will be put in the best possible condition. The Boomer road will return to electricity, and as soon as weather permits will be extended to the Michigan Central Railroad depot, and a loop made at Walkerville.

**Halifax, N. S.**—The Chief Justice has delivered judgment in the case of Holey vs. The Halifax Street Railway Company and the Nova Scotia Power Company, in an application on a summons to appoint a receiver of receipts and earnings of the property covered by a mortgage made to secure an issue of bonds for $250,000. The order granted provides that a receiver be appointed with the usual powers, unless the interest due on the bonds in litigation be paid into court within a certain time.

**Niagara.**—There is now little doubt that the electric railway recently constructed from Chippewa to Queenston along the Niagara River is part and parcel of the Canadian Pacific Railway system. The purchase of the Clifton House property clinches the fact. There is also no longer any doubt that the same road will soon have a bridge across the Niagara River, either at Niagara Falls or Queenston, and in fact it is stated on excellent authority that the bridge is now nearly constructed in the shops of the Hamilton Bridge Company, and will be ready for shipment in a few weeks.

**The Waterloo County Electric Railway** has issued a prospectus. The capital is to be $150,000, divided into 4,500 shares of $100 each. The scheme proposes to build an electric railway from Galt through Preston, Freeport and Berlin to Waterloo; also to utilize the water power of the Grand River where practicable, for manufacturing electricity for light, heat and power. The prospectus further says that Mr. Chapman, C. E., of Toronto, is engaged in making a survey of the proposed route and sections.

**The Canadian General Electric Company** is making preparations for the establishing of its business at London, Ont. Plans have been prepared for the erection of a power house, which will be 85 by 130 feet, and will have from 1,000 to 1,200 h. p. boilers and engines, with the necessary dynamos to produce the required electrical power. The engine and dynamo rooms will be 85 by 60 feet, and the boiler rooms 85 by 40 feet. The structure will be but one story. The cost of establishing the plant throughout will be $100,000.

## ENGLISH NOTES.

*(From Our Own Correspondent.)*

LONDON, March 29, 1893.

**Hopkinson Three-Wire Patent.**—The Westinghouse company has succeeded in obtaining a royalty of £2 10s. per annum per ton of copper laid under the streets from the Dundee Town Council.

**Liverpool Overhead Railway.**—This line was opened to the public on Monday, 6th inst., a 10-minute service being commenced with. Some 17,500 passengers were carried on the first day, 4,500 being first class. Complaints of overcrowding are already rife.

**Electricity Supply Rebates.**—The London Electric Supply Corporation appear to have hit upon a system of rebates which in principle is admirable from both the electricity supply companies' point of view and that of the consumer, viz., a rebate based on the number of units consumed per annum *per lamp fixed*. Unfortunately as the first reduction does not come into force until 35 kilowatt hours have been used by each 8-c. p. lamp (equivalent to 1,100 hours per annum), the benefits of the scale are somewhat illusory.

**City & South London Railway.**—The overcrowding on this railway, which has been a constant source of complaint for some time past, gave rise to a public statement in the House of Commons. The president of the Board of Trade stated that his department had communicated with the company on the subject and that the company had replied that they were using every endeavor to meet the traffic by the construction of additional sidings and the duplication of the portion of their line within the city boundaries.

**Gas Engine Electric Lighting.**—A somewhat remarkable scheme has been recommended by Prof. A. B. W. Kennedy to the Belfast Town Council. The employment of gas engines in small electric lighting stations dotted over a town at convenient spots has been strenuously advocated by Mr. Denny Lane, of the Cork Gas Consumers' Company, but up till now it has not been favored by leading electric light engineers in this country. Prof. Kennedy has, however, now recommended a scheme of this character for adoption at Belfast.

**Municipal Electric Lighting.**—The accounts for 1892 in connection with the Brighton Town Council electric lighting undertaking have just been published. They show a total income of close upon £4,700, and a total expenditure of nearly £2,500, the balance of £2,200 being absorbed by interest on capital and sinking fund. Thus, within 18 months of the station coming into operation and in face of a false start on the two-wire system, the corporation has succeeded in balancing its accounts. It may be hoped that as time goes on and the present judicious management continues, there will before long be a balance in reduction of the rates.

**The London County Council and the Electric Railways.**—On the occasion of the second reading of the bill brought in by the City & South London Railway for extending its line right across to the north of London, an attempt was made by the representatives of the London County Council to obtain the insertion of a clause reserving to the County Council power to purchase the undertaking upon fair terms at the end of a certain period. This proposition, although reasonable in itself, was brought forward in such a maladroit manner that it was on that account, as much as for reasons of policy, rejected by a large majority. It is satisfactory to note that the representatives of the County Council appear at last to have become alive to the fact that their policy of endeavoring to absorb all manner of private ventures is in some danger of extinguishing private enterprise altogether.

**Woodhouse & Rawson United (Limited).**—I mentioned some months ago that the largely advertised firm of Woodhouse & Rawson United (Limited) which in its latest shape has been at the back of some of the worst possible types of company promoting, was giving signs of a collapse. On Dec. 22 last such a state of things was disclosed that a committee of investigation was appointed. This committee's report has been published and has practically sealed the doom of the company as at present constituted. What has long been known to those behind the scenes is now set forth in black and white, viz., that the manufacturing business of the company, to which it originally owed its good name, has been both neglected and mismanaged. Dividends of 15 per cent. were indeed declared during the first two years of the present company's existence, but the profits out of which they were met were of a fictitious character. At the meeting on Dec. 22 a small sum of money was raised, secured on the trading stock of the company, for the purpose of keeping the concern going until the shareholders could ascertain the exact financial status of Woodhouse & Rawson United (Limited). However, it has now been found necessary to appoint a receiver. So far as the industry at large is concerned, the collapse is an unmitigated benefit. The company was doing little or no honest trading business and was rapidly bringing electrical finance into the same disrepute it suffered from in the palmy promoters' days of 10 years ago.

# News of the Week.

## THE ELECTRIC LIGHT.

**Madison, Me.,** has in view the erection of a municipal electric lighting plant.

**An electric light plant** is to be constructed at Snake Hill, N. J., at a cost of $135,000.

**Macon, Ga.,** is contemplating a bond issue of $500,000 to pay for an electric light and water works.

**The Lamberton (N. J.) Electric Light, Heat and Power Company** is to erect an electric plant.

**Weymouth, Mass.,** has appointed a committee to investigate and report on the subject of electric street lighting.

**The P. Claus Dynamo Company** was incorporated on the 5th inst., under the laws of the State of New York, with a capital of $100,000. P. Claus is president, H. Claus vice president, and A. Bower, treasurer. The business has hitherto been conducted by the P. Claus Company, and will now be continued by the new firm at the same address, 550 and 552 West Thirty-sixth street, New York.

## THE ELECTRIC RAILWAY.

**Little Valley, N. Y.,** is taking steps to secure an electric lighting system.

**Michigan City, Ind.**—An electric railway will be constructed at a cost of $25,000.

**Creston, Ia.,** is considering the question of owning and operating an electric light plant.

**Navarre, O.,** is advertising for proposals for the construction and operation of a street railway line.

**Binghamton, N. Y.**—An appropriation of $33,000 has been made for lighting the state hospital by electricity.

**Toledo, Ia.**—A 25-year franchise has been granted to T. L. Seavirs for an electric road and electric light and power plant.

**The Charlerol, Pa., Light, Heat and Power Company** has completed arrangements for putting in an electric lighting plant.

**Frankfort, Ind.,** is negotiating for an electric railway, the promoters of the enterprise being White & Morris and G. A. Smith.

**Atlanta, Ga.**—Franchises have been granted to the Lithia Spring Railway Company, to construct 10 miles of electric street railway.

**The Scranton (Pa.) & Abingdon Street Railway Company** has been incorporated to build a nine-mile road from Scranton to Waverly.

**College Station, Tex.**—An appropriation of $10,000 has been authorized for an ice plant and an electric light plant for the Agricultural College.

**Cantonsville, Md.**—A new company, of which W. H. Hardey, of Clarksville, is president, has been organized to construct an electric street railway.

**Pittsburgh, Pa.**—Surveys are being made for the proposed Pittsburgh, Neville Island & Coraopolis Electric Railway, to cost, including a bridge, $500,000.

**Spring Lake, Mich.**—A project is being considered for an electric railway to Hockley Park, about eight miles distant. Mr. D. R. Watters is interested.

**The Chester, Darby & Philadelphia Railway Company** has been granted authority to erect poles and string wires in Chester and Sharon Hill, Pa.

**Appleton, Wis.**—The citizens of Appleton, Neenah, Oshkosh and other cities have under consideration an electric system giving the Fox River Valley an electric road from Green Bay to Oshkosh and Berlin.

**Chillicothe (O.) Electric Railway and Lighting Company,** together with the Juneman electric light plant, has been sold to a New York syndicate for $140,000. The company will expend $40 000 in laying new tracks, making a two-mile extension and purchasing new cars.

**The Wheeless Conduit Electric Railway system** was recently given a trial on the Washington & Arlington Railway at Washington, D. C., which, it is claimed, was very successful. This is an underground system consisting of a conduit 16 inches deep and 17 inches wide, between 40-pound T rails and yokes and 40-pound slot rails. The conductors are in lengths of 200 feet, insulated from each other, and carrying no current except when the car is moving over them. A cable of stranded copper wire laid parallel with the track serves as a feeder. The car carries several cells of storage batteries, and when it enters a section, by energizing an electromagnet it makes temporary connections between the conductor and the feeder through the medium of a switch contained in an iron switchbox placed in the ground. The car is the ordinary type, equipped with two 20-h. p. motors. The conduit system has been constructed by Pepper & Register, of Philadelphia, under the designs of Mr. William Chapman, an English engineer.

## MISCELLANEOUS NOTES.

**Mr. Wm. Hazelton** has been appointed assistant general manager of the Short Electric Railway, Cleveland, O. Mr. Hazelton has been connected with the company for a number of years.

**Mr. C. McL. Paine** has assumed the business management of the *Architects' Electrical Bulletin*. Mr. Paine is well known in the electrical field from his connection with the *Western Electrician* and later with *Electricity*, and his journalistic experience as well as his personal popularity especially fit him for successfully discharging the duties of his new position.

**Changes in the Brush Electric Company.**—Mr. Charles N. Black has been appointed assistant superintendent of the Brush Electric Company. He is a graduate of Princeton College, and subsequently pursued a course in electrical engineering under Prof. Brackett, after which he entered the Brush shop, and by his ability and energy has risen to the position he now occupies. Nearly all of the foremen of the Brush works have been with the company from six to fifteen years, which is a high compliment to their abilities. Mr. Charles W. Phibbs has been appointed superintendent of the Brush Electric Company, of Cleveland, Ohio, in place of Mr. F. A. Scheffler, resigned. Mr. Phipps has been connected with the Brush company for a number of years. In 1879 he went to England to install the first English Brush plants, and in 1880 he went to Japan and China, where he spent three years superintending the construction of a large number of Brush plants. He was subsequently superintendent of construction for the Eastern district of the Brush company, with headquarters at New York. In 1891 he went to Cleveland as assistant superintendent of the works. His long experience and recognized ability well qualify him for the position to which he has been appointed. Mr. H. J. Wendorff has been appointed general purchasing agent of the Brush Electric Company. Mr. Wendorff, for a number of years, has had charge of the Brush stock rooms. He takes the place of L. W. Bradley, resigned.

# Industrial and Trade Notes.

**The Eureka Oil Purifier Company,** of Philadelphia, Pa. reports increasing demands for its apparatus, and is anxious to secure agents in every section of the country.

**The Berlin Iron Bridge Company,** of East Berlin, Conn., has received the contract for the new rolling mill building from the New Haven Rolling Mill Company at New Haven, Conn.

**Queen & Co.,** incorporated, Philadelphia, Pa., are meeting with a strong demand for their magnetic vane ammeters and voltmeters, and report double the sales during 1892 of any previous year.

**The Carbon County Electric Railway Company,** of Mauch Chunk, Pa., is about to commence work, and has advertised for bids on three miles of road construction, four car equipments and station apparatus, including two generators of 100 h. p. each.

**Mr. Frank B. Rae,** of Detroit, Mich., who is well known as the inventor of the Rae street railway motor, has removed his office to 49 Wilcox street, where he has secured a handsome three-story brick building for his offices and laboratory, and there he is installing improved machinery and apparatus for experimenting and testing work in connection with his business.

**The Builders' Iron Foundry,** of Providence, R. I., has shipped to Chicago a 36-inch Venturi meter manufactured under the patents of Clemens Herschel, C. E., New York City. This meter will be placed in the extreme southeast corner of the grounds and will measure the entire water supply of the Columbian Exposition (about 24,000,000 gallons a day). The recording apparatus will be exhibited in the adjacent building of the sewage cleansing works.

**The Michigan Electric Company,** of Detroit, Mich., has opened an office at 923 Hammond Building. This is a new firm consisting of J. E. Lockwood and George A. Mansfield, and proposes to do wiring and construction work as well as to manufacture electrical specialties, having secured all the rights and patents of the Lockwood Instrument Company. This company recently installed plants in the Riding Club Building, at Detroit, and in the residence of J. H. McMillan, son of Senator McMillan.

**The Ball engines,** manufactured by the Ball Engine Company, of Erie, Pa., continue to maintain their popularity for electric lighting and street railway work, four having been installed on four large lake steamers, built by the F. W. Wheeler Company, Bay City, Mich.; three cross compound condensing engines of 100, 150 and 200 h. p., in the power house of the Everett Street Railway Company, Everett, Wash.; and two 150-h.p. tandem compound condensing engines in the plant of the Alameda (Cal.) Street Railway Company.

**The Excelsior Electric Signal and Manufacturing Company** sends us some specimens of wire joints soldered with their improved soldering apparatus which make evident the advantages claimed. In some of the specimens the rubber insulation butts against the end of the soldered spiral and yet the insulation is apparently entirely intact. A defective joint accompanies the others, which showed a resistance of 1.7 ohms and is one of a dozen or more found in a length of 700 feet. As the line carried 15 amperes the loss from these joints during the 2½ years they were in use was no small matter, and emphasizes the importance of good joints and proper tools for making them.

**The Murphy Iron Works,** Detroit, Mich., manufacturers of the Murphy smokeless furnace and automatic stoker, are shipping a number of their stokers to various electric and street railway plants. The East Cleveland Electric Railway Company has already fourteen in use and has ordered seven more. Five stokers are to be shipped to the Calumet Street Railway Company, Chicago, one to the Chicago Illuminating Company, two to the Edison Electric Light Company of Erie, Pa., fourteen to the Auditorium Hotel, Chicago, twelve to a large sugar refinery in the same city, twelve to the Cambria Iron Works, Johnstown, Pa., which company already has thirty-two in use, and two to Howard & Higbee, Cleveland, O.

**The Detroit Electrical Works,** of Detroit, Mich., have just finished four direct connecting multipolar generators of 15 kw., 125 volts at 550 revolutions, for two new boats of the Detroit Navigation Company, and have also shipped to George Beatty, Boston, Mass., one 10-h. p., 500-volt motor and one 7½-h. p. motor; Farrand & Votey Organ Co., Detroit, one 45-kw. generator; Bagley estate, Detroit (third order), one 45-kw., 125-volt generator complete with engine, marble switchboard, etc.; H. H. Walter, Cincinnati, O., one 10-h. p., 125-volt motor, one 7½-h. p., 500 volt motor and one 5-h. p., 250-volt motor; complete plant for steamer Garland, one 7½-kw., 125-volt generator; Electrical Supply and Engineering Company, Detroit, for the National Cycle Company, Bay City, one 10-kw., 125-volt generator; Michigan Telephone Company, Detroit, two 15-kw., 125-volt direct connecting generators. Detroit Electrical Works are also busy with a large number of contracts for lighting and street railway work.

**Riehle Bros. Testing Machine Company,** Philadelphia, report the following very recent orders: American Telephone & Telegraph Co, New York, one 30,000-lb. vertical screw power testing machine; Syracuse Water Board, Syracuse, N. Y., one Riehle U. S standard 1,000-lb. cement testing machine, complete with molds, sieves, mixing table, and special appliances; Metropolitan West Side Elevated R. R. Co., Chicago, Ill., one 1,000-lb. U. S. standard cement testing machine, with worm gear, rubber pointed grips, and sundry appliances; Leland Stanford, Jr., University, Palo Alto, Cal., one 20,000-lb. vertical screw power testing machine, with indicator; Chicago, St. Paul, Minneapolis & Omaha Ry. Co., St. Paul, Minn., one 150,000-lb. screw power testing machine, with vernier poise beam and tools for tensile, compression

and transverse strains; Maine State College, Orono, Me., one 60,000-lb. vertical screw power testing machine complete; University of California, Berkley, Cal., one 5,000-lb. transverse testing machine, with indicator for elastic limit; Madison Car Company. Madison, Ill., one 5,000-lb. transverse testing machine, with indicator; Ewart Manufacturing Company. Indianapolis, Ind., one 20,000-lb. horizontal screw power testing machine; L. Hilgartner & Son. Baltimore, Md., one marble basin hole cutter; A. Plamondon Manufacturing Company, Chicago, Ill., one 3,000 lb. transverse testing machine, with indicator; Gillett-Hetzog Manufacturing Company, Minneapolis, Minn., one 5,000-lb. transverse testing machine, with indicator, for testing specimens 48 in. long; and other smaller orders.

"**The Buyers' Reference,**" published by The Buyers' Reference Company, 114 Nassau street, New York City, of which Mr. N. W. Gage is president and Mr. R. D. McCartie secretary and treasurer, has recently appeared, and this, its first edition, has met with merited success. Its character is briefly expressed in the sub title—"A Textbook, Classified Directory and Illustrated Descriptive Catalogue." It has been the aim of the publishers to place in the hands of the buyer a classified collection of information and data relative to the particular class of apparatus in which he is interested, and thus save him an endless search through catalogues and advertisements which is often as unsatisfactory as it is incomplete. *The Buyers' Reference*, for convenience, has been divided into separate editions, one covering the street railway field, another the light and power interests, and a third the supply and construction business. It is evident that the same idea can be extended not only into other branches of the electrical field, but into other fields as well, and such, we believe, is the intention of the publishers. In addition to the classified and illustrated descriptions of various kinds of apparatus, much valuable information has been compiled. For example, the section on arc lamps is preceded by a collection of pointers on arc lamps, and the subject of wiring is completed by an excellent set of tables, safe rules for wiring, etc., which should prove of great value to the practical man. In connection with this publication, the publishers also conduct an information bureau where the latest and most complete catalogues, circulars and other printed matter are indexed and kept in the most convenient form for ready reference.

## Business Notices.

**Transformers** rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

**Oil Filters** for sale cheap. Prices on application to Purity Oil Filter Manufacturing Company, 991 Water street, Pittsburgh, Pa.

**Battery Cut-out, Cheap.**—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

**Bedell & Crehore's Alternating Currents of Electricity.**—What is said of it: "It seems to me to be a lucid and valuable presentation of the subject and one that will fill an important place among electrical works."—Prof. H. A. Newton, Yale. "I have no hesitation in expressing the opinion that the electrical profession are greatly indebted to you for the enterprise you have shown in the publication of works of high character and standard value, of which this and the treatise of Crosby and Bell are conspicuous examples."—Franklin Leonard Pope.

# OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

## UNITED STATES PATENTS ISSUED APRIL 4, 1893.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

**494,562. Telautograph;** Elisha Gray, Highland Park, Ill. Application filed July 16, 1887. The combination with the transmitting pen and the rod of the flexible connection by which the pen is free to be adjusted to any inclination in any direction.

**494,565. Controlling Switch for Electric Motors;** Warren S. Hill, Boston, Mass. Application filed March 31, 1892. In an electric switch, the combination with the pivoted break switch arm, of a locking bar for the arm, a stop controlled by the break switch arm and controlling the resistance switch, and a resistance switch controlling the locking bar.

**494,585. Means for Electrically Heating Crucibles;** Willis Mitchell, Malden, Mass. Application filed June 13, 1892. In combination with a crucible consisting of two insulated parts of electrically conducting material, a holder which is provided with a handle adapted to be held by the hand, and with two terminal plates in contact with the said parts respectively, these plates being insulated from each other and forming part of an electric circuit.

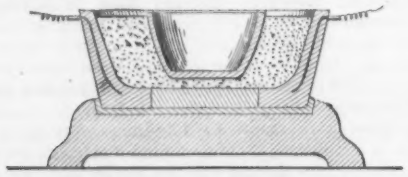
**494,586. Apparatus for Electrically Heating Crucibles;** Willis Mitchell, Malden, Mass. Application filed July 28, 1892. A heating receptacle for crucibles and other articles and substances, consisting of the conducting end sections of relatively high resistance having electrical circuit connections, in combination with the interposed U-shaped insulating strip and the filling of pulverized conducting material. (See illustration.)

**494,587. Electric Coal-Mining Machinery;** Edmund C. Morgan, Chicago, Ill. Application filed July 6, 1891. In a mining machine the combination with mechanism for driving the tool, a frame having apertures, elastic buffers in such apertures, and an extension or sleeve inclosing the spring and provided with flanges or a base plate detachably secured to the frame whereby the buffers are held in place. (See illustration.)

**494,596. Police Patrol System;** John Henry Ring, of Lowell, Mass., Assignor of three-eighths to James H. Pindar, Freeman W. Puffer and Dennis J. Ring, of same place. Application filed June 21, 1892. In a police patrol system, signal box having compartments, and having each compartment provided with a chain and handcuff, said chain being firmly attached to the signal box.

**494,608. Means for Switching of Motors in or out of Circuit;** Nathan Van Denburgh and Frederick H. Loveridge, Chicago, Ill. Application filed Feb. 23, 1892. The method of cutting out a dynamo electric machine from operation which consists in first cutting the field magnet out of the main circuit and into a local circuit, and then cutting the armature out of the main circuit and into a local circuit, and then, or simultaneously with the last action, opening the local field magnet circuit.

**494,610. Electric Switch;** Geo. Washington Webb, Wilkes-Barre, Pa., Assignor of one-half to Walter Gaston, of same place. Application filed April 20, 1892. In an electric switch the combination of the base; the line contacts and lamp contacts thereon; the line-segment and lamp-segment having arcuate rims substantially as described and the means for limiting the movement of the switch, consisting of the arcuate slot in the rim of the line-segment, and a screw passed through said slot and into a line-contact as explained.



No. 494,586.—Apparatus for Electrically Heating Crucibles.

**494,629. Commutator-Brush for Dynamos;** David W. Dunn, Pittsburgh, Pa. Application filed Aug. 13, 1892. A commutator brush of pulverized carbon and silicate of soda having sheets of copper gauze interspersed therein.

**494,657. Electric Meter;** Milton E. Thompson, Boston, Mass. Application filed May 19, 1891. In an electric meter for the measurement of alternating electric currents, the combination with an armature consisting of a hollow closed conductor of copper or other non-magnetic conducting material, of series coils, through which passes the current to be measured, and shunt coils arranged with their common axis at right angles to the common axis of the series coils and connected as a shunt across the circuit leading to the translating devices, these combined parts constituting an electric motor which develops a torque proportional to the energy passing through the motor.

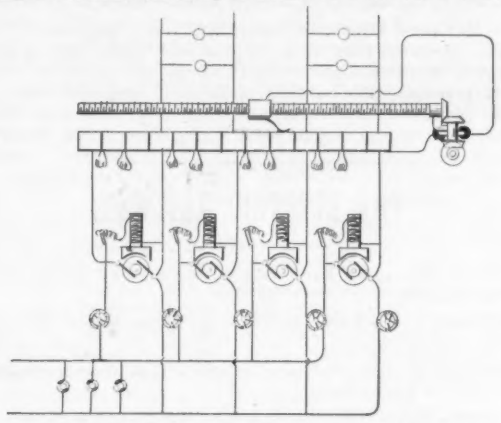
**494,705. Electric-Locomotive Regulation;** Rudolph M. Hunter, Washington, Pa., Assignor to the Thomson-Houston Electric Company, Connecticut. Application filed July 12, 1892. The combination of a vehicle, two or more electric motors upon the vehicle to propel it, a source of electric energy of constant potential, means controllable by hand for varying the counter electromotive force of the motors, and electric circuits for putting the electric motors in electrical connection with the source of electric energy and maintaining at all times the armatures in fixed series working relation with the field magnets and the individual counter electromotive forces of the several motors equal or substantially equal.

**494,721. Electric Railway Trolley;** Edward Martyn, Detroit, Mich. Application filed Sept. 19, 1892. In an electric trolley, the combination of the trolley-wheel having an apertured hub, said hub having a recess in each end thereof around said aperture, the balls located in said recess, the spindle passing through said hub, the cones loosely mounted on said spindle and adapted to extend into the recess in the ends of said hub, and the springs bearing against said cones to hold them in contact with the said balls.

**494,739. Brush-Supporter for Dynamo Electric Machines;** Axel. Ekstrom, Lynn, Mass., Assignor to the General Electric Company, New York. Application filed Nov. 16, 1892. A brush support for a dynamo electric machine consisting of two independent pivoted semi-circular portions making a split ring nearly surrounding the commutator, and means for securing the two portions together.

**494,750. Switch for Electrical Currents;** Henry Price Ball, Schenectady, N. Y. Application filed July 1, 1892. The combination in a switch for electric currents of a base having erected or mounted thereon a set of terminal clips, having pivoted or hinged therein two blades on a common centre, said blades and a second set of clips in the path of said blades with which the two blades can engage and make contact, and springs whereby said blades are held together normally one above the other and means for operating the other blade independently of the lower blade, through a certain distance as specified.

**494,762. Electrical Annunciator;** John B. Rogers, Washington, D. C. Application filed May 31, 1892. In an annunciator, the combination of an arbor, a sleeve disposed on said arbor, an indicating cylinder fixed to said sleeve and provided with a reel hub, ratchet wheel also fixed to said sleeve, actuating means having a constant tendency to rotate said sleeve, a vibratory



No. 494,842.—Electric Lighting System.

escapement lever pivoted to alternately engage and release said ratchet wheel, means for actuating said lever to release said cylinder and permit it to rotate, a cord wound on said reel by the rotation of said cylinder and restoring mechanism to reset said cylinder to its normal position.

**494,765. Means for Closing an Electric Circuit;** Harry L. Tyler, Corning, N. Y. Application filed Aug. 20, 1892. The combination of an electrical circuit having suitable terminals and a movable diaphragm in said circuit having a reflecting surface and caused to vibrate through the action of light on said surface to control said circuit.

**494,781. Circuit Controller for Electric Motors;** Warren S. Hill, Hyde Park, Assignor to the W. S. Hill Electric Company, Boston, Mass. Application filed May 16, 1892. The combination with an elevator tank, a pump, and a motor connected with said pump of a revolvable switch in the circuit of said motor, and having a toothed wheel, a pawl engaging the teeth of said wheel, a solenoid having its core connected with said pawl to rotate the wheel and switch, and means whereby the circuit of said solenoid is opened and closed.

**494,786. Automatic Cut-Out for Electric Signaling-Boxes;** Jacob F. Mehren, Chicago, Ill., Assignor to the Gamewell Fire Alarm Telegraph Company, of New York, N. Y., and Chicago, Ill. Application filed Jan. 8, 1892. In combination with a box having a door automatic electric-signaling apparatus, a key for manual signaling and a relay in the circuit thereof, and a cut-out or switch operated automatically by closing and opening the door to separate the key-contacts and thereby cut-out the relay and to switch the circuit.

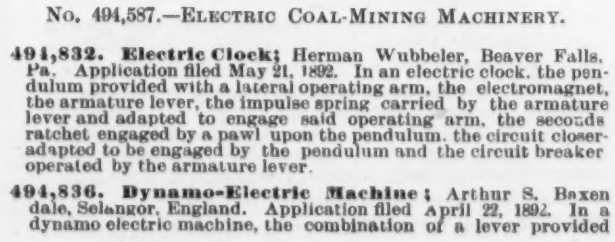
**494,787. Automatic Cut-Out for Electric Signaling Mechanisms;** Jacob F. Mehren, Chicago, Ill, Assignor to the Gamewell Fire Alarm Telegraph Company of New York and Chicago. Application filed Jan. 8, 1892. A signaling device for an electric signaling box, having in its circuit separable switch contacts and separable signal contacts, and a member operating directly on the switch contacts to maintain them normally in mechanical contact with each other and operating directly on the signal contacts to maintain them normally out of mechanical contact with each other, whereby a circuit is normally established around the signal contacts.

**494,827. Voltaic Cell;** Edward Weston, Newark, N. J. Application filed Nov. 24, 1891. A voltaic cell, the electromotive force of which is practically independent of temperature changes substantially as and for the purposes set forth. (See illustration.)

**494,828. Electrical Measuring Instrument;** Edward Weston, Newark, N. J. Application filed Jan. 14, 1892. In an electrical measuring instrument operated by the expansion or contraction of an electrical conductor, an elongated conducting body in circuit, extending abutments, and two more supports between said abutments so located as to cause said conductor in passing over them to form a single open loop.

**494,829. Recording Voltmeter;** Edward Weston, Newark, N. J. Application filed March 18, 1892. Two oppositely wound coils in electrical circuit supported on a common pivot shaft and vibrating in a field of force, an arm actuated by said shaft, a tracing device controlled by said arm, a moving record surface upon which said tracing device marks and means for directing a current into one or the other of said coils as the electrical pressure rises above or falls below a given point in a circuit including said means.

**494,830. Ground Detector for Electric Circuits;** Edward Weston, Newark, N. J. Application filed Sept. 10, 1892. In an electrical measuring instrument, a coil vibrating or oscillating in a field of force, an index actuated thereby, a fixed resistance in circuit with one terminal of said coil and in combination with the other terminal of said coil means for moving said other terminal into electrical connection with one or the other of two separate conductors.



No. 494,587.—Electric Coal-Mining Machinery.

**494,832. Electric Clock;** Herman Wubbeler, Beaver Falls, Pa. Application filed May 21, 1892. In an electric clock, the pendulum provided with a lateral operating arm, the electromagnet, the armature lever, the impulse spring carried by the armature lever and adapted to engage said operating arm, the seconds ratchet engaged by a pawl upon the pendulum, the circuit closer adapted to be engaged by the pendulum and the circuit breaker operated by the armature lever.

**494,836. Dynamo-Electric Machine;** Arthur S. Baxendale, Selangor, England. Application filed April 22, 1892. In a dynamo electric machine, the combination of a lever provided with anti-friction rollers, a pair of magnets, a pair of bobbins wound with insulated wire and mounted at the ends of the lever in spaces between the pole pieces of the magnets, and a pair of continuously revolving wheels having ratchet teeth, which alternately act on the anti-friction rollers of the lever.

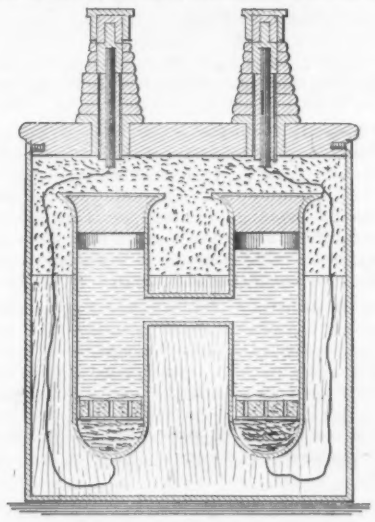
**494,842. Electric Lighting System;** Samuel W. Rushmore, Brooklyn, N. Y. Application filed Feb. 7, 1891. In a system of electrical distribution, the combination of two or more dynamo electric machines, means controlled by the current for connecting them successively in series, and a series circuit of translating devices one terminal of which is connected with a terminal of the series of dynamos, while the other terminal is adapted to be connected either with the opposite terminal of the series of dynamos or with the terminals of intermediate dynamos of the series, and means controlled by the current to automatically change the connection of the latter terminal whereby the number of dynamos in series may be varied to contain a constant current in the circuit. (See illustration.)

**494,849. Separator for Battery Elements;** Chaimsonovitz P. Elieson, New York, N. Y., Assignor of one-half to Francis A. Pallas, Oggebbio, Italy. Application filed July 9, 1892. As an improved article of manufacture, a separator for the coils of electric batteries having outer and inner electrodes comprising a skeleton frame of the shape approximating that of the electrodes, the frame having an open end, a supporting bottom, and slotted sides to permit the passage of an electrolyte through it.

**494,852. Galvanic Battery;** Derick H. Fitch, Cazenovia, N. Y. Application filed Nov. 22, 1892. A battery comprising a jar, a cylindrical carbon therein having smooth inner and outer walls its entire length, a zinc bar within the carbon, a cover supported by the bar, and a means for connecting wires with the carbon and zinc.

**494,856. Electric Generator or Motor;** Walter Thomas Goolden and Llewelyn Birchall Atkinson, London, England. Application filed Jan. 3, 1893. In a dynamo electric generator or motor, having a flame-tight casing, completely surrounding the armature, commutator and brushes constructed in parts hinged together and with means for fastening the same.

**494,871. Trolley Pole Catcher;** Edward L. Langheinz, Brooklyn, N. Y. Application filed Nov. 10, 1892. A catcher for trolley poles, comprising a counteracting spring device on the bracket frame support of the pole, the springs of which are stronger than the lifting springs for the pole, and held dormant while the trolley wheel on the pole is engaged with a line wire and released when said truck is displaced from the line wire.



No. 494,827.—Voltaic Cell.

**494,923. Jail Door Alarm;** Wm. S. Hull, Sheffield, Ala. Application filed Sept. 19, 1892. In jails, prisons and the like structures, the combination with a door having a rod projecting from it substantially in line with its hinge and provided with an arm located at a point inaccessible from the door of a spring plate carrying a push button normally help by said plate in contact with said arm when the door is closed, a contact plate carried by the push button and normally held by said contact plate, with a companion plate, and an open electrical circuit having therein an alarm and an automatic drop connected with each other and with the battery which is in said circuit.

**494,961. Electrical Measuring Instrument;** Adolf Koepoel, Berlin, Germany, Assignor to Siemens & Halske, of same place. Application filed Nov. 17, 1892. In a current measuring instrument, the combination with a divided conductor, of a magnet having its poles located between the divisions of the conductors, a soft iron needle pivotally supported between the poles of said magnet, a pointer, and a scale over which the pointer travels.

**494,964. Galvanometer;** Edwin F. Northrup, Ardmore, Assignor to Samuel L. Fox and Edward B. Fox, Philadelphia, Pa. Application filed Nov. 5, 1892. In a galvanometer, the combination of the energizing coils with a moving system having two or more magnets suspended upon a shaft having freedom of movement and provided with one or more movable or adjustable parts adapted to modify the magnetic lines of force of any or all the magnets.

**494,978. Electric Motor;** Francis B. Crocker and Schuyler S. Wheeler, New York, N. Y., Assignors to the Crocker-Wheeler Electric Company, of same place. Application filed June 20, 1892. An electric motor sustained on an inclined base pivotally supported and having a fan attached to its armature shaft, whereby the motor and its attached parts rotate around the pivotal support when the fan is set in motion.

**494,995. Cut-Out for Brush Lamps;** Benjamin Adair and Chas. H. Klewer, Denver, Colo. Application filed Nov. 18, 1892. In the brush arc lamp the combination with the solenoids, consisting of the main and shunt coils, an electromagnet having its coils interposed in the shunt circuit, a short circuit through the armature of the magnet, and another short circuit composed of a contact carried by the heel piece or armature of the solenoids, another contact on the lamp frame, a resistance coil and suitable connections whereby the lamp is cut out of the circuit as soon as the heel piece drops.

*Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.*

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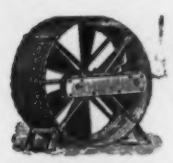

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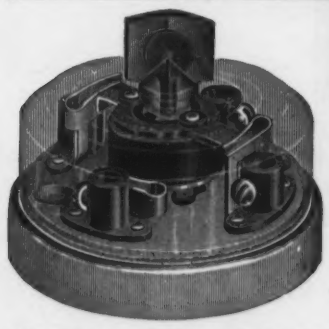

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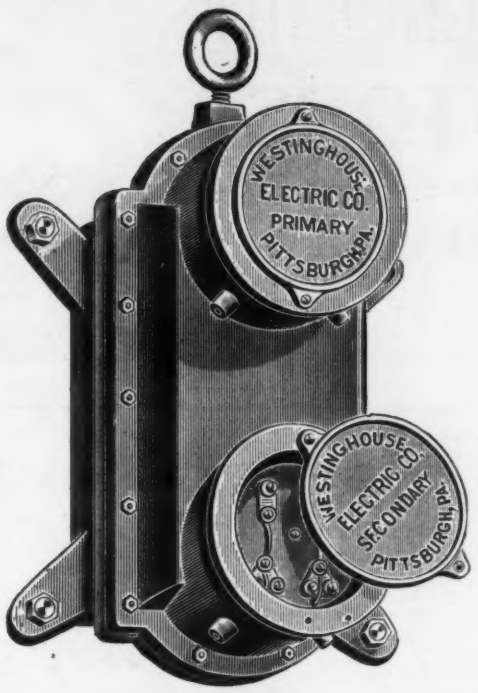


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